DOCUMENT RESUME

ED 317 383	SE 051 286

AUTHOR	Landis, David; And Others
TITLE	Super Saver Investigators: An Elementary, Interdisciplinary, Environmental Studies Activity Guidebook about Solid Waste and Natural Resources.
INSTITUTION	Ohio State Dept. of Natural Resources, Columbus.
PUB DATE	90
NOTE	392p.
AVAILABLE FROM	Ohio Dept. of Natural Resources, DLPR, Fountain Square, Building F-2, Columbus, OH 43224 ($25.00, contact for quantity prices).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Elementary Education; *Elementary School Science; *Environmental Education; Interdisciplinary Approach; *Natural Resources; Professional Development; Science Activities; *Science and Society; Science Curriculum; *Science Materials; *Solid Wastes; Wastes
IDENTIFIERS	*Ohio

ABSTRACT

This is an elementary, interdisciplinary, environmental studies activity guidebook about solid waste and natural resources. "Super Saver Investigators" what solid waste is, where it is generated, how we manage it and could manage it better, and the consequence of mismanagement. It contains many hands-on, skill enhancing activities for elementary students. Reference indexes and a glossary are provided. Chapters included are: (1) "The Matter of Wastes"; (2) "People and Wastes"; (3) "Nature's Way with Wastes" (4) "Technology and Waste"; (5) "Recycling and Saving Resources"; (6) "Waste Out of Place"; (7) "Unnatural Hazards in Nature"; (8) "Hazards in the Built Environment"; (9) "Waste Age Choices"; (10) "Waste and Wasteful Habits"; (11) "Getting Out the Message"; (12) "Reuse Enterprises"; (13) "Work, Waste, and Money"; (14) "Machines to the Rescue"; and (15) "Citizens to the Rescue." (YP)

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SUPER SAVER INVESTIGATORS

An elementary, interdisciplinary, environmental
studies activity guidebook about
solid waste and natural resources

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Ohio Department of Natural Resources
Division of Litter Prevention & Recycling

Richard F. Celeste, Governor
Joseph J. Sommer, Director

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Super Saver Investigators is endorsed by the Ohio Department of Education as providing opportunities to fulfill the "Energy and Resource Conservation" mandate. *Super Saver Investigators* is made available to schools and teachers in Ohio on an inservice basis. Interested parties should contact the Division of Litter Prevention & Recycling:

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ACKNOWLEDGMENTS

Many people participated in the development of this curriculum. Most of the ideas for activities were generated, and tested in classrooms, by elementary teachers in Ohio. They are listed below, followed by the name of their school district.

Kathleen E. Adams
Ashland City

Bruce Averell
Cuyahoga Falls City

Gerda Barr
Southwestern City

Roger Brown
Switzerland of Ohio

Linda Campbell
Columbus

Paul Carpenter
Miami Trace

Cheryl Cunningham
Columbus

Sharon Dawson
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Celeste F. Geise
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Brenda J. Green
Licking Heights

Kathy Jaffee
Oberlin

Regina James
Painesville City

Marilee King
Trotwood-Madison

Ed Kramer
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Poland Local

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Lancaster City

Martha Leuzinger
Three Rivers Local

Marcia Long
Hillsdale

Kathryn Loxley
Jackson City

Barb Matheny
Findlay City Schools

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Betty Myers
TriValley Local

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Jo Parkey
Vandalia-Butler City

Carla Paulin
South-Western City

Mary Jo Powell
Franklin City

Carolyn Sacks
Warren City

Ernest Scherzer
Strongsville

Janet Slattery
Athens City

Rosalie Spencer
East Liverpool City

Elaine Struck
New Carlisle-Bethel

Lebby Little Vantine
Ohio Valley Local

Marilyn Weiler
Highland

Della Ewalt, Jim Petuch and Diana Rogers were local litter prevention and recycling program Education Specialists who provided additional activity ideas for the guide.

It would not have been possible to prepare this guidebook without the commitment and continuing patient support of Ohio Department of Natural Resources Director Joseph Sommer, Assistant Director Chuck Mauger, and Deputy Directors Tom Sherman and Anne Wickham.

David Landis of the Division of Litter Prevention & Recycling (DLPR) was primarily responsible for the design, construction and text preparation. Editorial reviews and valuable insights were provided by George Peters of the DLPR and by John Hug of the Ohio Department of Education.

The Division appreciates the initial support and encouragement given by John Bartley of Springfield City Schools, Lynn Elfner of the Ohio Academy of Science, and Robert Roth of the Ohio State University School of Natural Resources.

The Division thanks Jeff DeVito of Milliron Recycling for his contribution to the June 1986 Teachers Workshop.

Additional editorial reviews and research assistance were provided by the following DLPR staff: Andrea Ceisler, Lisa Curran, Mary Douglas-Lacy, Anne Filbert, Betsy Sopko, and Carol Simpson. Word processing was done by Cathy Stamm. Illustrations are by Tim McCauley of *Diphrent Strokes* (Columbus, OH).

PREFACE

Ohio today faces a solid waste crisis. We generate ever increasing amounts of solid waste while our waste disposal capacity constantly diminishes. When these two developments converge we will experience a crisis. Not least among the consequences will be reversal of Ohio's recent success in preventing litter. Ohioans have long enjoyed convenient and inexpensive solid waste disposal and have not given the matter much thought. Informed public opinion, intelligent public decision making and public action are called for now to forestall and ease the crisis.

The Ohioans who follow us will have to contend with their waste and with the waste they inherit from us. From us they will inherit waste management methods and habits, and they will devise their own methods, all of which will have practical limitations. They will face the same potential convergence of waste and disposal capacity, and the same need to forestall and ease the crisis. We owe them the least waste and the best methods and habits possible. We owe them something more. The next generation of Ohioans should be adequately informed about our waste and prepared with the skills to make intelligent decisions about what to do with it. They should have the opportunity to think about waste before they must contend with it as a public crisis.

Super Saver Investigators is about solid waste, what it is and where it is generated, how we manage it and could manage it better, the consequences of mismanagement and the drain on our natural resources our waste represents for the environment.

Super Saver Investigators contains many hands-on, skill enhancing activities for elementary students. The ideas for these activities were generated at a week long workshop by a select group of Ohio elementary teachers actively involved in environmental studies education. The fruits of their labor are recommended to teachers and school districts and also to public agencies and parents who wish to teach children about an important local, state, national and international environmental issue.

Super Saver Investigators is produced as part of a comprehensive effort by the Ohio Division of Litter Prevention & Recycling to foster responsible waste management practices. The goal *Super Saver Investigators* is intended to serve through public education is to change for the better Ohioans' attitudes and behaviors toward their wastes.

Mary L. Wiard

Mary L. Wiard, Chief
Division of Litter Prevention & Recycling
Ohio Department of Natural Resources

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THE SOLID WASTE CRISIS IN OHIO

What Is Happening

Beneath the manifestations of our affluence — the high-rise buildings, the shiny automobiles, the aisles of abundant foodstuffs — is a behemoth growing on trash and garbage. Each individual feeds this creature several pounds of solid waste each day. In Ohio this adds up to more than 10 million tons of solid waste each year. Some solid waste is misplaced and stays with us as irritating litter, but most of it is buried in the ground.

There is a problem: the amount of solid waste we produce is increasing, while the amount of land in which we can safely bury it is decreasing. 48 of Ohio's 88 counties are expected to run out of approved landfill space by 1991.[1] States east of Ohio that have already encountered the same problem have begun exporting solid waste to Ohio. Environmentalists and legislators now speak of a growing solid waste crisis.

We cannot ignore the problem. It will not go away. If we do not act the result will be the pollution and degradation of the land and waters on which we live and of which we are the stewards.

What Is to Be Done

Our nearly total reliance on inexpensive landfilling as the primary method of solid waste disposal has contributed to our solid waste crisis. However, we will never be able to abandon completely the practice of landfilling solid waste. We must find more land in which to bury solid waste, but it will be harder to do and more expensive. Proposed new landfill sites must meet geological standards to protect against groundwater pollution. Once sited an approved modern sanitary landfill facility is subject to strict guidelines and tough enforcement. The costs of waste management facilities accordingly go up. As Ohio grows, landspace becomes more valuable for residences, farming, industry and wildlife protection. If like our eastern neighbors we export our waste westward, we can add the cost of transportation to our final waste disposal bill.

There is no single simple solution. What is called for is a comprehensive approach to solid waste that includes workable ways of reducing significant portions of the solid waste stream, in addition to appropriate placement and safe operation of sanitary landfills. Comprehensive planning and policy formation by citizens, communities, government officials and representatives of business and industry will be necessary. In planning we will have to take into account all the methods of waste reduction we can find.

There are four commonly recognized ways of dealing with solid waste other than landfilling. We can *reduce* the amount of waste we produce by consuming less packaging and fewer goods in the first place. We can *reuse* some consumer durables and build them for extended life. In doing so we postpone the time at which they become waste to go to the landfill. We can *recycle* some of our waste and postpone indefinitely the need to landfill it. We can *incinerate* solid waste that would otherwise go to the landfill to significantly reduce its volume. By reducing the amount of waste to be landfilled, each alternative conserves landfill space, thereby postponing the necessity of condemning another piece of land to use as a landfill. Reduction, reuse and recycling save landfill space, but they also save energy and other natural resources. Similarly when waste is incinerated in energy recovery systems to produce heat or electricity natural resources that would otherwise be burned are conserved.

Each alternative has its limitations and its costs. In terms of impact on the environment, reduction and reuse are the best alternatives, but they do not promise to address a large enough portion of the solid waste stream. Waste incineration systems are expensive, have the potential for air pollution, and produce ash which must be appropriately landfilled.

The Ohio Division of Litter Prevention & Recycling (DLPR) recommends that recycling be taken seriously in solid waste planning. There are recycling systems and technologies for paper, yard waste, glass, plastic, aluminum, rubber, oil, steel and other materials. 50% of Ohio's solid waste stream is recyclable material, but it is not practically possible to recycle all of this. DLPR estimates that 25% of all of Ohio's solid waste could be collected, cleaned and marketed.

The most efficient way to channel these materials away from the waste stream is through community recycling efforts, called source separation programs. Source separation means consumers separate glass, aluminum and paper products (and possibly many other items) at their homes and take the separated materials to recycling centers or put them out at the curb so that special recycling collection trucks can pick them up. Source separation already exists in Ohio in communities that have for-profit and/or not-for-profit recycling collection centers which provide consumers the opportunity to recycle. A few communities have initiated, or plan to initiate, curbside collection of recyclables. School and civic groups collect recyclables for many reasons. By recycling they make money to support charities or to purchase band costumes and other school-related items.

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[1] "Understanding Ohio's Solid Waste Crisis," The Ohio Alliance for the Environment (September, 1986).

Many Ohio recyclers are motivated by an environmental ethic. Nothing is more valuable for the perpetuation and protection of the natural environment than nature's own recycling process. Recycling human-made materials is an attempt to incorporate some of the balance and efficiency of nature's way with waste into our own interactions with the environment. Because the recycling of human generated waste conserves energy and natural resources and reduces environmental pollution, a recycling ethic should be as strong as the anti-littering ethic has proven to be in Ohio.

Source separation in Ohio has been conducted on a small voluntary scale but much more is possible. One important means to motivate citizens to recycle and to implement recycling opportunities is to educate our young about the values of recycling and about careful waste management that is necessary to conserve resources and protect the environment.

What Educators Can Do

The youth of America can be taught about the threat to our environment created by litter, improper waste disposal and the failure to reduce, reuse and recycle. Through the use of appropriate learning activities, such as those offered in this guide, elementary students should be able to *reason* why they should not litter, why they should recycle and why they should take a public interest in how waste is disposed of in their communities. "Why?" is one of the first and most persistent questions asked by young children. Instead of presenting answers directly, the activities in this guidebook provide hands-on experiences as well as skill-building handouts in a manner which allows each student to investigate and discover for himself or herself why he or she should become a **Super Saver:**

- A **Super Saver** of nonrenewable resources and energy.
- A **Super Saver** of land.
- A **Super Saver** of wildlife and of human health.
- A **Super Saver** of an aesthetically pleasing environment.

The activities in this guidebook provide opportunities for students to investigate the environmental impacts of the generation of large quantities of waste in our society and to investigate solutions to the waste crisis. The activities cross disciplines to link subjects of science, social studies and language arts, often including exercises related to arts and crafts, drama and music. The activities have also been designed to improve life-long learning skills that include reading skills, writing skills, math skills and the ability to hypothesize, to conduct experiments, to make inferences and deductions, to record data, to think and write creatively and to collect information from reference sources. Ample opportunities are also made available to improve social skills and to build individual self-confidence through the use of skill-building handouts and activities that require cooperation in groups, role playing, and artistic creation.

Super Saver Investigators is recommended as an instructional tool that can be used to meet many of the requirements of the "Energy and Resource Conservation" mandate of the Ohio Department of Education. The Ohio Department of Education recommends that, in regard to components, concepts and understandings in Energy and Resource Conservation Education, the following be considered:

1. That recognized environmental issues such as "disposal of hazardous waste, chemical contamination of food and water supplies, resource depletion, and aesthetic degradation" be a part of environmental education in the classroom.
2. That the seven topical categories of "energy, food and fiber, population, land use, goods and services, environmental quality, and resource use" be discussed and studied.
3. That the ideal way to learn about environmental issues is in an interdisciplinary curricular organization involving "aesthetic, economic, ethical, governmental, mathematical, political, scientific, sociological, and technological aspects" of complex issues.
4. That consideration be given to the fact that in many schools departmentalization of elementary and secondary education requires that "these environmental issues be integrated into the disciplinary curriculum."[2]

Super Saver Investigators is both comprehensive and flexible enough to meet these particular recommendations, offering teachers a wide variety of activities to choose from that can be integrated into what is normally taught.

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[2] *Energy and Resource Conservation*, Minimum Standards Leadership Series 1985, Ohio Department of Education, p.14.

HOW TO USE THE GUIDEBOOK

The activities in *Super Saver Investigators* form an environmental studies curriculum integrating special concepts and subjects in science and social studies with life-long learning skills. Two indexes are provided to help teachers find activities that are compatible with what they normally teach during the school year. The **Science and Social Studies Index** is a guide for finding activities that relate to specific concepts and skills in elementary science and social studies. (Many of these activities contain language, math and/or fine arts exercises.) The **Learning Skills Index** is a guide for finding activities that enhance particular life-long learning skills. A **Special Subject Index** is provided identifying activities that relate to particular subjects of waste management and to specific educational concerns such as activities appropriate for the gifted or for school fund raising projects, etc. These three indexes are in Section B.

Background Information has been provided in seven of the fifteen chapters of activities. The first two chapters of background information and activities serve as an introduction to solid waste concerns: Chapter One deals with science concepts and Chapter Two with social studies concepts. It is recommended that the background information of these first two chapters be read carefully and that a selection of activities from these two chapters be used before others to introduce students to solid waste problems. To help teachers understand the broad range of subjects associated with waste management, an outline of all the subjects addressed in the seven chapters of background information is provided below. (The italicized, numbered items are important terms and concepts which are helpful to know when conducting the activities. Additional terms and concepts appear in the *vocabulary* of each activity and are defined in the glossary.)

OUTLINE OF BACKGROUND INFORMATION AND WASTE CONCEPTS INTRODUCED

CHAPTER I: THE MATTER OF WASTE

A. What are we throwing away?

1. *garbage*
2. *refuse*
3. *rubbish*
4. *trash*
5. *scrap*
6. *solid waste*
7. *refuse analysis*
8. *municipal solid waste*

B. Reduce and Reuse

1. *reduce*
2. *reuse*

C. Recycling and Saving Resources

1. *waste*
2. *useful*
3. *recycle*
4. *renewable resources*
5. *non-renewable resources*

D. Understanding Waste and the Disposal of Waste

1. *decomposition*
2. *biodegradable*
3. *non-biodegradable*
4. *weathering*
5. *oxidation*
6. *organic*
7. *inorganic*
8. *human-made*
9. *natural*

E. Landfills and What Happens to Waste in Them

1. *landfill*
2. *household hazardous waste*
3. *leachate*
4. *methane*

CHAPTER II: PEOPLE AND WASTE

A. Waste at Home, School and Work

B. Litter and Littering

1. *litter*

C. Litter and the Law

D. Keeping America Beautiful

CHAPTER III: NATURE'S WAY WITH WASTE

A. Nature's Recycling System

1. *decomposers*
2. *fungi*
3. *bacteria*
4. *humus*
5. *scavengers*
6. *dung*

B. Composting as a Form of Recycling and Waste Management

1. *compost*
2. *anaerobic bacteria*
3. *aerobic bacteria*
4. *aerobic composting*

C. The Requirements of Composting

D. Making Compost

E. When is compost ready?

F. Variables and Experimenting

G. The Value of Compost

CHAPTER IV: TECHNOLOGY CHANGING WASTE

A. Changing Properties of Waste Matter

1. *physical properties*
2. *chemical properties*
3. *energy recovery*
4. *resource recovery*
5. *isoform recycling*
6. *heteroform recycling*

B. Recycling Processes

1. *separation*
2. *transformation*
3. *contaminants*

C. Separation Techniques

1. *source separation*
2. *manual separation*
3. *mechanical separation*
4. *ferrous metals*
5. *nonferrous metals*

D. Transformation Processes

1. *physical changes in the state of matter*

E. Energy Recovery

1. *refuse derived fuel*

CHAPTER V: RECYCLING AND SAVING RESOURCES

A. Recycling Materials for Manufacturing

1. *primary materials*
2. *secondary materials*

B. Saving Energy

1. *fossil fuels*

C. Saving Resources

1. *nonrenewable resources*

D. Saving the Environment

E. Saving Resources by Burning Waste

1. *energy recovery systems*

F. The Incineration Controversy

1. *dioxin*
2. *fly ash*
3. *bottom ash*

CHAPTER VII: UNNATURAL HAZARDS IN NATURE

1. *accidents*
2. *bioaccumulation*

CHAPTER VIII: CHEMICALS AND WASTE MATTER: SOURCES OF POLLUTION

A. Chemical Compounds and Hazardous Waste

1. *elements*
2. *compounds*
3. *organic compounds*
4. *inorganic compounds*
5. *hazardous*
6. *acute toxicity*
7. *chronic toxicity*
8. *household hazardous waste*
9. *leachate*

B. Water and Toxic Waste

1. *groundwater*
2. *aquifers*
3. *surface water*
4. *nutrients*
5. *eutrophication*
6. *toxic organics*
7. *toxic metals*

C. Solid and Hazardous Waste Disposal: What can be done to protect health and the environment?

1. *biological treatment*
2. *physical treatment*
3. *chemical treatment*

D. Hazardous Waste Disposal and Legislation

1. *U.S. Environmental Protection Agency (EPA)*
2. *Resource Conservation And Recovery Act (RCRA)*
3. *Superfund*
4. *Clean Water Act*

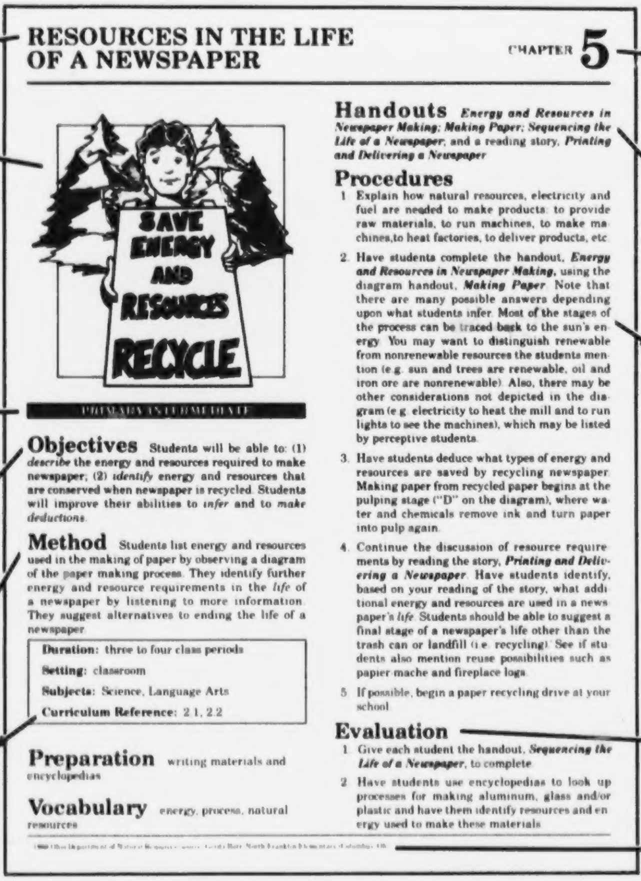
E. Household Hazardous Waste and What To Do With It

F. EXAMPLES OF HOUSEHOLD HAZARDOUS WASTE

G. A GUIDE TO SAFE DISPOSAL OF HOUSEHOLD HAZARDOUS WASTES

ACTIVITY DESCRIPTIONS

The layout of each activity description allows for ease in finding activities by chapter number, in using handouts and in understanding how to conduct each activity.



RESOURCES IN THE LIFE OF A NEWSPAPER

CHAPTER 5

SAVE
ENERGY
AND
RESOURCES
RECYCLE

PRIMARY INTERMEDIATE

Objectives Students will be able to: (1) *describe* the energy and resources required to make newspaper; (2) *identify* energy and resources that are conserved when newspaper is recycled. Students will improve their abilities to *infer* and to *make deductions*.

Method Students list energy and resources used in the making of paper by observing a diagram of the paper making process. They identify further energy and resource requirements in the *life* of a newspaper by listening to more information. They suggest alternatives to ending the life of a newspaper.

Duration: three to four class periods
Setting: classroom
Subjects: Science, Language Arts
Curriculum Reference: 2.1, 2.2

Preparation writing materials and encyclopedias

Vocabulary energy, process, natural resources

Handouts ***Energy and Resources in Newspaper Making; Making Paper; Sequencing the Life of a Newspaper***, and a reading story, ***Printing and Delivering a Newspaper***

Procedures

1. Explain how natural resources, electricity and fuel are needed to make products: to provide raw materials, to run machines, to make machines,to heat factories, to deliver products, etc.
2. Have students complete the handout, ***Energy and Resources in Newspaper Making***, using the diagram handout, ***Making Paper***. Note that there are many possible answers depending upon what students infer. Most of the stages of the process can be traced back to the sun's energy. You may want to distinguish renewable from nonrenewable resources the students mention (e.g. sun and trees are renewable, oil and iron ore are nonrenewable). Also, there may be other considerations not depicted in the diagram (e.g. electricity to heat the mill and to run lights to see the machines), which may be listed by perceptive students.
3. Have students deduce what types of energy and resources are saved by recycling newspaper. Making paper from recycled paper begins at the pulping stage ("D" on the diagram), where water and chemicals remove ink and turn paper into pulp again.
4. Continue the discussion of resource requirements by reading the story, ***Printing and Delivering a Newspaper***. Have students identify, based on your reading of the story, what additional energy and resources are used in a newspaper's *life*. Students should be able to suggest a final stage of a newspaper's life other than the trash can or landfill (i.e. recycling). See if students also mention reuse possibilities such as papier mache and fireplace logs.
5. If possible, begin a paper recycling drive at your school.

Evaluation

1. Give each student the handout, ***Sequencing the Life of a Newspaper***, to complete.
2. Have students use encyclopedias to look up processes for making aluminum, glass and/or plastic and have them identify resources and energy used to make these materials.

Title of activity

Action or message illustration indicating skill or theme which is the focus of the activity

Indication of appropriate grade levels

Content and learning skills (in italics) described

General description of activity

Reference to concepts in Science and Social Studies Index

Chapter designation in corner, away from spine, for easy reference

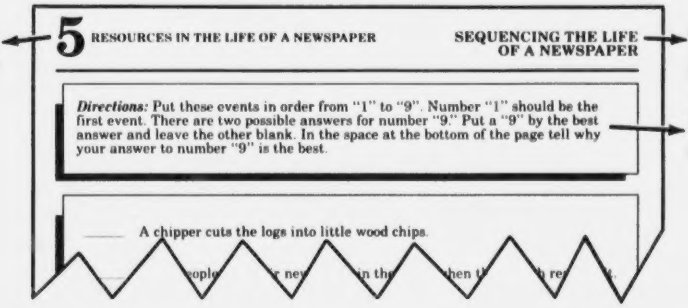
All handouts listed in order of their use in the **Procedures**

Step by step explanation for conducting activity

Method(s) of evaluation described

Source of activity identified

HANDOUT FORMAT



5 RESOURCES IN THE LIFE OF A NEWSPAPER

SEQUENCING THE LIFE OF A NEWSPAPER

Directions: Put these events in order from "1" to "9". Number "1" should be the first event. There are two possible answers for number "9." Put a "9" by the best answer and leave the other blank. In the space at the bottom of the page tell why your answer to number "9" is the best.

____ A chipper cuts the logs into little wood chips.

Title of activity beside chapter number (away from spine for easy reference)

Title of handout (toward spine)

Directions for completing the handout

REFERENCE INDEXES

SCIENCE AND SOCIAL STUDIES INDEX . . . . p. B-2
LEARNING SKILLS INDEX . . . . p. B-7
SPECIAL SUBJECT INDEX . . . . p. B-11

In each index, activities are listed under various categories. For each activity, the chapter in which it may be found is indicated in parentheses, and letters designate recommended grade levels. Only two grade level designations have been made:

"P" (primary) indicates activities appropriate for grades K-3

"I" (intermediate) indicates activities appropriate for grades 4-6

Most of the activities can either be modified by teachers or only partially used to be made appropriate for any elementary grade level (hence the P/I indication in the case of many activities). At the end of the Special Subject Index is a listing of activities which are recommended for gifted intermediate age students or for students in junior high classrooms.

SCIENCE AND SOCIAL STUDIES INDEX

For each lesson concept described below one or more activities are listed by chapter (in parentheses). The index is based on the following numerical-decimal system:

Science

1. = Physical Science concepts
2. = Earth Science concepts
3. = Natural Science concepts
4. = Human Health concepts

Social Studies

5. = Geography concepts
6. = Economics concepts
7. = Human Behavior concepts
8. = History and Democracy concepts

SCIENCE CONCEPTS

1. PHYSICAL SCIENCE: MATTER AND CHANGES IN MATTER

1.1 **Properties of matter** Materials have special physical properties that can be detected by use of the senses. These properties include color, shape, texture, weight and odor. The properties of materials are important for specific uses.

Litter Dictionary Competition	(1)	I
Magnets and Metaphors	(4)	P/I
Recycling Paper	(4)	I

1.2 **Changes in matter** Change means that things become different over time. Changes can be produced by people, by natural forces; some changes are slow, some are rapid. Changes in matter can be observed and described.

Decomposition Conditions	(1)	I
The Tiny Beastie's Feast	(3)	I
To Burn Or Not To Burn	(4)	I

1.3 **States of matter** Matter can change form to be one of three states: solid, liquid or gas. When matter changes from one form to another, the total amount of matter remains unchanged. Temperature changes have effects on matter; heat is important for turning a solid into a liquid or a gas.

Recycling Plastic	(4)	I
To Burn Or Not To Burn	(4)	I
The Shape Of Recycling	(4)	I

1.4 **Sorting and separating** Objects can be sorted and separated based on physical and chemical properties. These properties include the abilities to float or sink in water, to bend or break under pressure, to be attracted to magnets or not, to support combustion or not.

Catch 'Em If You Can	(4)	P
Magnets And Metaphors	(4)	P/I
Separation Mania	(4)	I

1.5 **Physical and chemical changes** Changes in matter can be distinguished as either physical changes or chemical changes, based on physical and chemical properties of matter. Physical properties related to physical changes include boiling and freezing points and the ability to bend or break under pressure. Chemical properties related to chemical changes include the ability to rust or to burn.

Recycling Paper	(4)	I
Recycling Plastic	(4)	I
The Shape Of Recycling	(4)	I
To Burn Or Not To Burn	(4)	I

1.6 **Machines** Machines are devices that make work easier by changing the direction of a force applied to an object. Examples of simple machines are inclined planes, levers, pulleys, gears and wheels and axles. Compound machines are machines made up of more than one simple machine.

The Great Can Crusher Contest	(14)	I
Changing Matter In Analogous Ways	(14)	I
Recycling Systems Make Sense	(14)	I

1.7 **Systems** Systems are defined by the interaction of objects which create changes in matter. Systems can be machines or living organisms. Systems are often described as cycles. Analogies can be made based on descriptions of two or more cycles or systems.

Natural Recycling	(3)	P/I
The Great Can Crusher Contest	(14)	I
Changing Matter In Analogous Ways	(14)	I
Recycling Systems Make Sense	(14)	I

2. EARTH SCIENCE: SOURCES OF ENERGY AND MATERIALS

2.1 **Sources of energy** Most of the energy we use is the energy of the sun stored in fuels. Fossil fuels extracted from the earth are used widely in industrial societies to provide energy. Coal, oil and gas are nonrenewable sources of energy which can be saved by using alternative forms of energy.

Resources In The Life Of A Newspaper	(5)	P/I

2.2 **Sources of materials** The earth supplies us with materials that we use to make products. These materials can be identified as made from either renewable resources or made from nonrenewable resources. Consequences of the increasing use of nonrenewable resources can be predicted hypothetically.

Useful Waste	(1)	P/I
Natural Resources And Waste Materials	(1)	P/I
The Original Source	(5)	P/I
How Much Do We Use?	(5)	I
Resources In The Life Of A Newspaper	(5)	P/I
When They're Gone, They're Gone	(5)	I
Resources Simulation	(5)	P/I
Industry Changing Waste	(9)	I
Recycling Dramas	(11)	I

2.3 **Soil quality** Good soil is a valuable resource. The contents and characteristics of good soil and poor soil can be identified. Poor soil can be enriched. Good soil can become contaminated by pollution.

Compost Dwellers	(3)	I
The Tiny Beastie's Feast	(3)	I
Deadly Drink	(7)	I

2.4 **Types of soil** Different types of soil (clay, loam, sand) hold different amounts of water.

Compost Dwellers	(3)	I

3. NATURAL SCIENCE: LIVING ORGANISMS AND ECOSYSTEMS

3.1 **Ecosystem** Organisms live and interact with each other in particular environments. These environments can be defined as habitats or as ecosystems which provide the needs of plants and animals. Ecosystems involve boundaries and relationships among plants and animals which can be described through careful observation.

The Alien Litter	(1)	I
What's Under Water?	(7)	P

3.2 **Food chain** Living organisms need other living or non-living things for food. Living things can be affected by polluted soil, water, or air. Contaminants can be passed along food chains concentrating in ever greater quantities, sometimes ending with human consumption.

Deadly Drink	(7)	I
Concentrated Chemicals	(7)	I
Fishy Fish	(15)	I

3.3 **Decomposition** Scavengers and decomposers return minerals to the soil and keep dead matter from accumulating in the environment. Decomposers include bacteria and fungi (molds, mushrooms, yeast); scavengers include rats, snails, hyenas, sea gulls.

Decomposition Conditions	(1)	I
Natural Recycling	(3)	P/I
Compost Dwellers	(3)	I
The Tiny Beastie's Feast	(3)	I

3.4 **Wildlife** Animals move and acquire food in many ways. They fly, hop, swim, go slow or go fast to travel or to catch food. Animals seek different forms of shelter for warmth, reproduction and protection from predators.

The Alien Litter	(1)	I
How Did This Happen?	(7)	P
Shabby Shelter	(8)	P/I

4. HUMAN HEALTH: POLLUTION AND THE ENVIRONMENT

4.1 **Disease organisms and harmful chemicals** Small animals and microorganisms are dependent on an environment suited to their needs for food, water, temperature and shelter. To meet their needs some organisms, which are harmful to human health, can enter the human body in many ways: through breaks in skin or through contaminated water supplies. Harmful chemicals that have contaminated plants or animals can be ingested by humans creating health problems.

Shabby Shelter	(8)	P/I
Litter Really Hurt Me	(8)	I
Fishy Fish	(15)	I

4.2 **Protecting health** People can change the environment of disease organisms to protect human health. Water can be purified through filtration and through the application of heat, cold, acids, salt solutions and antiseptics that inhibit bacterial growth. Toxic wastes can be treated and disposed of properly, techniques can be used to contain and dispose of waste materials so that they do not attract organisms harmful to human health.

Is The Water Fit To Drink?	(8)	I
Hazards And Waste	(8)	I
Industry Changing Waste	(9)	I
Fishy Fish	(15)	I

SOCIAL STUDIES CONCEPTS

5. GEOGRAPHY: PLACES PEOPLE LIVE, WORK AND PLAY

5.1 **Community and Home** People live in homes with different rooms. People live, work and play in diverse ways in different communities: urban, suburban, rural, ranch. Communities are maintained by the interactions of people working in different occupations. People also interact for enjoyment through participation in recreational activities.

It All Begins At Home	(2)	P
Waste In The Workplace	(2)	I
Map Out Litter	(2)	P/I
At The Source	(2)	P/I
Litter By Community	(2)	I
Time To Celebrate! But Wait!	(2)	I
What's Under Water?	(7)	P
Count Down To Litter	(10)	P
The Litter Alert	(11)	P/I
It Has To Be Dealt With	(15)	P/I

5.2 **Geographical regions** The United States is made up of geographically diverse regions that include plains, deserts, seacoasts, plateaus, highlands, etc.

This Littered Land Is Your Land	(6)	P/I

5.3 **Aesthetic appreciation** Natural and built environments have beauty that can be appreciated. They provide for aesthetic needs of people. People have feelings about specific features of natural and built environments.

Map Out Litter	(2)	P/I
This Littered Land Is Your Land	(6)	P/I
Waste And Words	(6)	I
The Litter Poet	(6)	I

5.4 **World Geography** The United States shares similar problems with other countries of the Earth.

Pollution Around The World	(8)	I

5.5 **Solar system** The Earth is part of a solar system.

Waste In Space	(6)	I

6. ECONOMICS: MAKING CHOICES ABOUT THE USE OF RESOURCES

6.1 **Choices and resources** Individuals, families, communities and nations must make choices about using resources to satisfy needs and wants and to protect the future supply of resources. People spend money to get things they need or want. Consumer decisions are an important part of a free enterprise economy.

Useful Waste	(1)	P/I
To Buy Or Not To Buy	(9)	P/I
You Have A Voice	(15)	I

6.2 **Starting a business** Business enterprises provide goods and/or services to a community. Young students have skills and resources to contribute to an enterprise: either profit or nonprofit in nature. Students can identify their own resources (wagon, bike, personal skills) and skills which can be used to provide goods and services for others. Aside from personal resources, there are many other requirements for starting a business.

Recycleville,USA	(12)	P/I
Ecology Cash	(13)	I
Our School Recycles	(13)	P/I

6.3 **Exchanging goods and services** Money is a medium of exchange that facilitates the distribution of goods and services. However, money is not always required to acquire or provide goods and services; sometimes old items can be traded or reused to create something artistic or useful or both. Based on supply and demand (needs or wants) objects have different values. These values can be expressed monetarily or by bartering one thing for another.

Trading Resources	(5)	P/I
Trash To Treasure Sale	(12)	P/I
Recycleville,USA	(12)	P/I
Dollars And Pounds	(13)	I

6.4 **Careers** Human resources used in the production of goods and services are shared through a division of labor. Career preparation is based on desire, education and occupations and opportunities available.

Careers In Waste Management	(13)	I

6.5 **World resources** People and nations are interdependent because they share the Earth's resources. Natural resources exist in varying amounts in different countries. Different countries produce and sell different resource materials and products to each other. Hypothetical predictions can be made as to what will happen as more and more nonrenewable resources are used to meet the world's economic needs.

Resources Simulation	(5)	P/I
When They're Gone, They're Gone	(5)	I
Resources And Conflicts	(5)	P/I

7. HUMAN BEHAVIOR: SOCIAL LIFE AND LEARNING

7.1 **Groups and behavior** People learn behaviors from the groups with which they interact. Family members, friends and peer groups influence how people behave. People have certain roles and status positions within groups. Different groups and individuals have different values.

Invasion Of The Pollutians	(10)	P
You Have Influence	(10)	I
You Have A Voice	(15)	I

7.2 **Norms, rules and laws** Members of groups are governed by norms, rules and laws. Norms are expected ways of behaving that can be expressed in rules or formalized into laws. Rules are based on particular situations at home, at school and in social organizations.

Ruling Out Litter	(15)	P/I

7.3 **Learning and habit formation** The ability to learn enables people to modify their behavior and their environment. Habits can be learned or changed through conditioning (behavior modification) and insight. People learn things from a variety of sources, including teachers, museums, books, parents, other students, the media and reference books.

How Much Do We Use?	(5)	I
Count Down To Litter	(10)	P
Survey Your Habits	(10)	I
Meritorious Behavior	(10)	P/I
The Litter Alert	(11)	P/I
Puppet Dramas	(11)	I
Recycling Dramas	(11)	I

7.4 **Symbols and signs** Symbols and signs in the environment evoke physical and psychological responses from people. Symbols and signs serve specific purposes and have special meanings.

Signs And Slogans	(11)	P/I

8. HISTORY AND DEMOCRACY: CHANGE AND PLANNING FOR THE FUTURE

8.1 **American history** American society has undergone many changes and continues to change. Specific changes have taken place in American life in the past 50 years which enable us to compare and contrast present lifestyles with those of previous generations. Changes have created new problems.

Waste In Space	(6)	I
The Wrap Up	(9)	P
To Buy Or Not To Buy	(9)	P/I
Industry Changing Waste	(9)	I
Trash In History	(9)	I

8.2 **Local democracy** Communities can plan to meet their needs in a democratic way. Local governments and town councils provide means for citizens to make decisions in their communities. The roles and functions of citizens as community members can be identified. There are consequences to be suffered if a community does not take care of its resources. Some community actions may not serve the public interest.

The Litter Alert	(11)	P/I
It Has To Be Dealt With	(15)	P/I
You Have A Voice	(15)	I
Fishy Fish	(15)	I

LEARNING SKILLS INDEX

THINKING SKILLS

CLASSIFY

Useful Waste	(1)	P/I
Natural Resources & Waste Materials	(1)	P/I
Waste In The Workplace	(2)	I
It All Begins At Home	(2)	P
Catch 'Em If You Can	(4)	P
Magnets & Metaphors	(4)	P/I
Separation Mania	(4)	I
The Original Source	(5)	P/I
Hazards And Waste	(8)	I
To Buy Or Not To Buy	(9)	P/I
The Wrap Up	(9)	P
Meritorious Behavior	(10)	P/I
Trash To Treasure Sale	(12)	P/I
Ruling Out Litter	(15)	P/I

RANK ORDER

Useful Waste	(1)	P/I
Decomposition Conditions	(1)	I
Fishy Fish	(15)	I

PROCESS ORDER

Natural Recycling	(3)	P/I
Resources In The Life Of A Newspaper	(5)	P/I
Our School Recycles	(13)	P/I
Recycling Systems Make Sense	(14)	I

MAKE CAREFUL OBSERVATIONS

Decomposition Conditions	(1)	I
The Alien Litter	(1)	I
Magnets & Metaphors	(4)	P/I
To Burn Or Not To Burn	(4)	I
Is The Water Fit To Drink?	(8)	I
You Have Influence	(10)	I

INTERPRET SYMBOLS ON A MAP AND FIND LOCATIONS

Map Out Litter	(2)	P/I
Fishy Fish	(15)	I

INTERPRET ILLUSTRATIONS

Map Out Litter	(2)	P
At The Source	(2)	P/I
Natural Recycling	(3)	P/I
Hazards And Waste	(8)	I
To Buy Or Not To Buy	(9)	P/I
Changing Matter In Analogous Ways	(14)	I
Recycling Systems Make Sense	(14)	I

WEBBING CONCEPTS

Natural Recycling	(3)	P/I
How Much Do We Use?	(5)	I

MAKE COMPARISONS AND ANALOGIES

The Alien Litter	(1)	I
Natural Recycling	(3)	P/I
The Shape of Recycling	(4)	I
Resources Simulation	(5)	P/I
When They're Gone, They're Gone	(5)	I
Resources And Conflicts	(5)	P/I
The Wrap Up	(9)	P
Changing Matter In Analogous Ways	(14)	I

MAKE INFERENCES AND DEDUCTIONS BASED ON REASONING

Decomposition Conditions	(1)	I
It All Begins At Home	(2)	P
Waste In The Workplace	(2)	I
At The Source	(2)	P/I
Litter By Community	(2)	I
Time To Celebrate! But Wait!	(2)	I
Compost Dwellers	(3)	I
Separation Mania	(4)	I
Resources In The Life Of A Newspaper	(5)	P/I
When They're Gone, They're Gone	(5)	I
Resources And Conflicts	(5)	P/I
How Did This Happen?	(7)	P
Concentrated Chemicals	(7)	I
Pollution Around The World	(8)	I
Hazards And Waste	(8)	I
Count Down To Litter	(10)	P
Careers In Waste Management	(13)	I
Changing Matter In Analogous Ways	(14)	I
Recycling Systems Make Sense	(14)	I
Fishy Fish	(15)	I

PROBLEM SOLVING AND DECISION MAKING SKILLS

RESEARCH USING SOURCES OF INFORMATION

The Original Source	(5)	P/I
Shabby Shelter	(8)	P/I
Industry Changing Waste	(9)	I
Changing Matter In Analogous Ways	(14)	I

CONDUCT A SURVEY

Litter Really Hurt Me	(8)	I
Trash In History	(9)	I
Survey Your Habits	(10)	I

COLLECT AND ORGANIZE DATA

Waste In The Workplace	(2)	I
How Much Do We Use?	(5)	I

IDENTIFY OR HYPOTHESIZE CAUSE AND EFFECT

Deadly Drink	(7)	I
Fishy Fish	(15)	I

ANALYZE CONSEQUENCES AND SUGGEST ALTERNATIVES

When They're Gone, They're Gone	(5)	I
Waste In Space	(6)	I
To Buy Or Not To Buy	(9)	P/I
Trash To Treasure Sale	(12)	P/I
You Have A Voice	(15)	I

CONDUCT EXPERIMENTS TO TEST HYPOTHESES OR TO TEST VARIABLES USING TEST SAMPLES AND CONTROL SAMPLES

Decomposition Conditions	(1)	I
The Tiny Beastie's Feast	(3)	I
To Burn Or Not To Burn (demonstration)	(4)	I
Deadly Drink	(7)	I

PROPOSE SOLUTIONS TO SCIENTIFIC PROBLEMS

Separation Mania	(4)	I
The Great Can Crusher Contest	(14)	I
It Has To Be Dealt With	(15)	P/I
Fishy Fish	(15)	I

PROPOSE SOLUTIONS TO PROBLEMS INVOLVING BEHAVIORS

Time To Celebrate! But Wait!	(2)	I
Resources And Conflicts	(5)	P/I
What's Under Water?	(7)	P
Invasion Of The Pollutians	(10)	P
Survey Your Habits	(10)	I
You Have Influence	(10)	I
Meritorious Behavior	(10)	P/I
The Litter Alert	(11)	P/I
Ruling Out Litter	(15)	P/I
It Has To Be Dealt With	(15)	P/I
Fishy Fish	(15)	I

PSYCHOMOTOR SKILLS

MANIPULATE MATERIALS TO CONSTRUCT PROJECTS

Natural Resources And Waste Materials	(1)	P/I
It All Begins At Home	(2)	P
Trading Resources	(5)	P/I
The Litter Alert	(11)	P/I
Puppet Dramas	(11)	I
Recycling Dramas	(11)	I
Recycleville, USA	(12)	P/I
The Great Can Crusher Contest	(14)	I
It Has To Be Dealt With	(15)	P/I

MANIPULATE EQUIPMENT AND MATERIALS FOR EXPERIMENTS AND DEMONSTRATIONS

Decomposition Conditions	(1)	I
The Tiny Beastie's Feast	(3)	I
Separation Mania	(4)	I
Recycling Paper	(4)	I
Recycling Plastic	(4)	I
The Shape Of Recycling	(4)	I
Is The Water Fit To Drink?	(8)	I

COMMUNICATION SKILLS

FOLLOW ORAL DIRECTIONS

It All Begins At Home	(2)	P
Map Out Litter	(2)	P/I

LISTENING CAREFULLY

Natural Recycling	(3)	P/I
Resources In The Life Of A Newspaper	(5)	P/I

EXPOSITORY WRITING

Time To Celebrate! But Wait!	(2)	I
To Burn Or Not To Burn	(4)	I
The Shape Of Recycling	(4)	I
Resources And Conflicts	(5)	P/I
Waste And Words	(6)	I
Concentrated Chemicals	(7)	I
Shabby Shelter	(8)	P/I
Hazards And Waste	(8)	I
Survey Your Habits	(10)	I
You Have Influence	(10)	I
Recycling Systems Make Sense	(14)	I
Fishy Fish	(15)	I

CREATIVE WRITING

Magnets And Metaphors	(4)	P/I
Waste And Words	(6)	I
This Littered Land Is Your Land (lyrics)	(6)	P/I
The Litter Poet (poetry)	(6)	I
Waste In Space	(6)	I
What's Under Water?	(7)	P
Shabby Shelter (script)	(8)	P/I
Pollution Around The World (news report)	(8)	I
To Buy Or Not To Buy (commercial)	(9)	P/I
Trash In History (essay)	(9)	I
You Have Influence	(10)	I
The Litter Alert (news broadcast)	(11)	P/I
Signs And Slogans (slogans)	(11)	P/I
Recycling Dramas (script)	(11)	I
You Have A Voice	(15)	I

CREATIVE DRAWING

Waste In Space	(6)	I
What's Under Water?	(7)	P
Shabby Shelter	(8)	P/I
The Wrap Up	(9)	P
Signs And Slogans	(11)	P/I

MATHEMATICAL SKILLS

COMPUTE FIGURES

How Much Do We Use?	(5)	I
Litter Really Hurt Me	(8)	I
Recycleville, USA	(12)	P/I
Ecology Cash	(13)	I
Dollars And Pounds	(13)	I

ESTIMATE QUANTITIES

It All Begins At Home	(2)	P
Waste In The Workplace	(2)	I

GRAPH DATA

Litter Really Hurt Me	(8)	I
Count Down To Litter	(10)	P
Survey Your Habits	(10)	I

READING SKILLS

INCREASING VOCABULARY AND USING DICTIONARIES

At The Source	(2)	P/I
Compost Dwellers	(3)	I
Recycling Plastic	(4)	I
This Littered Land Is Your Land	(6)	P/I
Hazards And Waste	(8)	I
Recycling Dramas	(11)	I
Dollars And Pounds	(13)	I

COMPREHENSION OF READING PASSAGES

The Alien Litter	(1)	I
Magnets And Metaphors	(4)	P/I
How Much Do We Use?	(5)	I
Waste In Space	(6)	I
Deadly Drink	(7)	I

FOLLOW WRITTEN DIRECTIONS

Recycling Paper	(4)	I
Recycleville, USA	(12)	I
The Great Can Crusher Contest	(14)	I

INTERPERSONAL RELATIONS SKILLS

WORK COOPERATIVELY WITH OTHERS

Litter Dictionary Competition	(1)	I
Decomposition Conditions	(1)	I
Trading Resources	(5)	P/I
Litter Really Hurt Me	(8)	I
Puppet Dramas	(11)	I
Recycling Dramas	(11)	I
Trash To Treasure Sale	(12)	P/I
Recycleville, USA	(12)	P/I
Our School Recycles	(13)	P/I
The Great Can Crusher Contest	(14)	I
Ruling Out Litter	(15)	P/I
You Have A Voice	(15)	I
Fishy Fish	(15)	I

DEVELOPING GROUP DISCUSSION

Useful Waste	(1)	P/I
Litter Dictionary Competition	(1)	I
Waste In The Workplace	(2)	I
Pollution Around The World	(8)	I

IMPROVING LEADERSHIP SKILLS

You Have Influence	(10)	I
Meritorious Behavior	(10)	P/I
You Have A Voice	(15)	I

SPECIAL SUBJECT INDEX

CONSERVATION - of energy & resources
  Resources In The Life Of A Newspaper (5)
  When They're Gone, They're Gone (5)
  Resources And Conflicts (5)
  Survey Your Habits (10)
  Meritorious Behavior (10)
  Recycling Dramas (11)

CONTAINMENT
  Map Out Litter (2)
  What's Under Water? (7)
  Count Down To Litter (10)

COMPOST
  Compost Dwellers (3)

COMPOST - making compost
  Background Information (3)
  The Tiny Beastie's Feast (3)

DECOMPOSITION RATES - of materials
  Decomposition Conditions (1)

GLOBAL EDUCATION
  When They're Gone, They're Gone (5)
  Pollution Around The World (8)

HAZARDOUS WASTE - household hazardous waste
  Hazards And Waste (8)

HAZARDOUS WASTE - community and industrial sources
  Industry Changing Waste (9)
  Fishy Fish (15)

HAZARDOUS WASTE (including human health)
  See "Wildlife" and "Pollution"

LITTER - laws
  Ruling Out Litter (15)

LITTER - clean-ups
  At The Source (2)
  Time To Celebrate! But Wait! (2)
  See "Containment"

LITTER - sources
  Litter By Community (2)
  At The Source (2)
  Time To Celebrate! But Wait! (2)

LITTER - affect on wildlife
  See "Wildlife"

LITTER - affect on human health
  Shabby Shelter (8)
  Litter Really Hurt Me (8)

LITTER - prevention
  Invasion of the Pollutians (10)
  Survey Your Habits (10)
  You Have Influence (10)

OUTDOOR ACTIVITIES
  The Alien Litter (1)
  Map Out Litter (2)
  At The Source (2)
  Natural Recycling (3)
  The Tiny Beastie's Feast (3)
  Waste And Words (6)
  The Litter Poet (6)
  Count Down To Litter (10)

POLLUTION
  Pollution Around The World (8)

POLLUTION - air
  To Burn Or Not To Burn (4)

POLLUTION - water
  Deadly Drink (7)
  Is The Water Fit To Drink? (8)
  Hazards And Waste (8)
  Fishy Fish (15)

PRE-POST TEST HANDOUT - litter laws
  Ruling Out Litter (15)

PRE-POST TEST HANDOUTS - recycling & saving resources
  When They're Gone, They're Gone (5)
  Recycling Dramas (11)

PUBLICITY - for clean-up
  The Litter Poet (6)
  This Littered Land Is Your Land (6)
  The Litter Alert (11)
  Signs And Slogans (11)
  Puppet Dramas (11)

PUBLICITY - for recycling drive
  The Litter Poet (6)
  Recycling Dramas (11)
  Our School Recycles (13)
  The Great Can Crusher Contest (14)

PUBLICITY - music
  This Littered Land Is Your Land (6)

PUBLICITY - drama
  Recycling Dramas (11)
  Puppet Dramas (11)

RECYCLING - identifying recyclables (& manual separation)
- Useful Waste (1)
- Litter Dictionary Competition (1)
- Waste In The Workplace (2)
- Catch 'Em If You Can (4)
- Magnets And Metaphors (4)

RECYCLING - school recycling drive
- Our School Recycles (13)

RECYCLING - money to be made
- Ecology Cash (13)
- Dollars And Pounds (13)

RECYCLING - recycling processes & machines
- Recycling Paper (4)
- Recycling Plastic (4)
- Changing Matter In Analogous Ways (14)
- Recycling Systems Make Sense (14)

REDUCE
- How Much Do We Use? (5)
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REUSE
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- Trash To Treasure Sale (12)
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SIMULATION ACTIVITIES
- Resources Simulation (5)
- When They're Gone, They're Gone (5)
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ROLE-PLAYING
- You Have Influence (10)
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WILDLIFE - and litter
- The Alien Litter (1)
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FOR GIFTED ELEMENTARY STUDENTS AND JUNIOR HIGH STUDENTS
- Decomposition Conditions (1)
- Waste In The Workplace (2)
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- Resources In The Life Of A Newspaper (5)
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- You Have Influence (10)
- Signs And Slogans (11)
- Recycleville, USA (12)
- The Great Can Crusher Contest (14)
- Changing Matter In Analogous Ways (14)
- Recycling Systems Make Sense (14)
- You Have A Voice (15)
- Fishy Fish (15)

GLOSSARY
SSI VOCABULARY

accident: an unintended event, usually unfortunate, resulting from carelessness or lack of awareness; can result from litter or the improper disposal of solid waste.

advertise: to attract attention to a product or service to promote sales.

aerobic: living only in the presence of oxygen; e.g. aerobic bacteria.

agriculture: cultivation of the soil to produce crops.

air pollution: contamination of the air in the environment with gases or particles of matter that can be harmful to living organisms.

alliteration: the use of similar consonant sounds in two or more neighboring words or syllables (e.g. "wild and woolly" and "threatening throngs").

alloy: a substance that is a mixture of two or more metals or of a metal and something else.

alphabet: the letters of a language arranged in a traditional order; in English, consisting of the letters a-z; also known as "The A, B, C's."

aluminum: a hard light metallic element found in the ore bauxite; aluminum is capable of being shaped or rolled very thin and is non-magnetic.

anaerobic: living in the absence of free oxygen; e.g. anaerobic bacteria.

analogy: a likeness in function, interactions or particulars between things otherwise unlike.

animal matter: any material or substance of an organism that is distinguished from a plant.

aquifer: an underground rock formation that contains significant amounts of groundwater and may supply water to wells and springs.

auction: a sale of goods, often used items, sold to the highest bidder.

awareness: possession of information that can lead to action.

bacteria: single celled microorganisms; found in many shapes and forms.

behavior: the manner in which a person acts in specific situations.

bimetal: composed of two different metals that are not fused together into an alloy.

biodegradable: capable of being broken down (decomposed) into basic elements by biological processes.

brand name: a trademark word or words used to identify a good as the product of a single firm or manufacturer.

calculate: to solve or find an answer using mathematical computations.

capital: machines and buildings used to make a product; money used by a business enabling it to make and/or sell a product.

career: a type of work or occupation related to particular tasks that often require training and education.

carnivore: an animal that eats other animals.

cause: people or things responsible for an action or result of an action.

cellulose: a chemical compound that is the chief part of plant tissues and fibers, used in the manufacture of paper and textiles.

change: the act or process of transformation; to become different over time.

chemical effect: something that happens caused by chemicals and chemical changes in matter.

classify: to assign to a category or to arrange according to a system.

clay: soil that is composed of fine particles which make it nonporous and pliable.

cleanup: an act of picking up waste and litter from one's surroundings; an act to beautify.

cloth: a pliable material made from natural (cellulose) or synthetic fibers and filaments.

collage: an artistic composition made of various materials or bits of objects glued on a picture surface.

collection: part of waste management in which trash and garbage are picked up and hauled away to be disposed of or recycled.

combustible: capable of being ignited or burned.

community: people living in a particular area that has distinctive geographical features and distinctive ways that people make a living.

community council: a group of people that meets to discuss important issues related to initiating policies for the good of the community.

compaction: compression of materials into a smaller space than they existed in originally.

compost: a mixture of mostly decayed organic matter that is used to restore nutrients and texture to soil.

compostable: having the ability to be broken down by microorganisms into compost; characteristic of much organic waste and some mineral waste.

conservation: protection of a natural resource to prevent it from being destroyed or used unnecessarily.

container: something that encloses and holds something else; waste materials are stored in waste containers before they are finally disposed of or recycled.

containment: the state of waste placed in containers so it can be collected for disposal or recycling; proper containment practices prevent litter.

contaminate: to make something unfit for use by contact or mixture with something else.

control sample: part of an experiment used to check the results of variables that are introduced.

country: the territory of a nation or state where people have particular ways of living and working.

data: facts and information used to discuss issues and to make calculations.

decomposer: a tiny organism that feeds on organic waste materials, breaking them down into constituent elements or compounds.

degrade: to harm something, such as the environment.

demand: how much something is wanted, especially in regard to purchasing goods or services.

design: to make a plan for a specific purpose.

desirable: having an effect that is beneficial to something, such as the environment.

disposal: the process of getting rid of waste; can be properly or improperly done, depending upon the consequences for the environment and public health.

distribution (of natural resources): the frequency of occurrence of resources on earth and the amount of resources consumed by different countries.

drama: a composition in prose or verse intended to portray behaviors and/or to tell a story.

dump: an open land site where garbage and trash are deposited; usually unsightly and possibly harmful in nature; often referred to as open dump, distinguished from a landfill.

dung: animal excrement or manure.

element: one of the 106 known substances of which all matter is composed. It cannot be divided into a different substance by ordinary chemical means.

energy: ability to perform work or produce a change.

environment: the circumstances or conditions that surround living organisms including people; includes everything around us — people, weather, animals, plants, soil, water, buildings.

evaluate: to determine the significance or worth of something by careful appraisal and study.

evidence: something (data) that furnishes grounds for adopting an opinion; is often gathered by careful observation and the keeping of records.

experiment: an activity undertaken to test a hypothesis or to demonstrate an accepted hypothesis.

export: to send something to another country or place for trade or sale.

extraction: the process of taking a resource from the earth and/or removing or separating (metal) from ore.

ferrous metal: metal containing iron; is magnetic which facilitates the separation of recyclable materials made from iron.

filter: a device for separating impurities from a liquid or gas as in the cases of polluted water and smoke in the air.

float: to remain suspended within or on the surface of a liquid without sinking.

food chain: organisms in a community that constitute a feeding chain in which food energy is transferred from one organism to another as each consumes a lower member and in turn is eaten by a higher member.

force: an agent or device that exerts energy causing an object at rest to move and/or changing the physical properties of the object.

formal sanction: a penalty that gives binding force to a law, often in the form of fines or jail sentences.

fuel: a material such as coal, oil, gas or wood which is burned to supply heat or power.

fungus: tiny plants showing no clear distinction of roots, stem or leaves, such as molds, mildews and mushrooms; can not make their own food as other plants do and therefore feed upon living or dead organisms.

garbage: organic food waste that is thrown away and decomposes easily.

generic name: a name applied to a whole kind or group of products having similar characteristics, which is not a trade name or trademark.

glass: a hard, brittle substance usually transparent or translucent made from minerals including sand silica (quartz and opal silica) which are fused with soda ash and lime.

goods: different types of products that can be bought or sold.

graph: a diagram composed of lines, curves, bars, etc.; used to summarize data.

habit: the tendency to repeat a certain pattern of behavior without forethought or deliberation.

habitat: the place where a plant or animal lives and grows.

harmful: causing or capable of causing physical or mental damage to living organisms.

hazardous: dangerous or perilous (see "hazardous waste").

hazardous waste: waste that provides special problems to living creatures or the environment because it possesses one or more of the following characteristics: poisonous, explosive, capable of dissolving flesh or metal, readily burnable with or without a flame, carries disease, is radioactive.

health: the overall condition of an organism, connoting physical and mental well-being and freedom from disease.

herbivore: a plant-eating animal.

human-made: consisting of materials manufactured by people.

humus: the organic part of soil, resulting from the partial decay of plant or animal matter.

hypothesis: a theory or supposition that is tentatively taken to be true; provides a basis for explaining certain facts; is investigated by conducting experiments.

ignitable: able to catch on fire or burn.

import: to trade with or buy goods from a foreign country or outside source.

improper waste disposal: any method of disposing of waste which causes aesthetic and/or environmental degradation, often posing a threat to the health of living organisms.

improve: to make better by changing one's behavior.

incineration: burning solid waste to reduce the volume; used in energy recovery processes to produce hot air or water, steam or electricity.

industrialization: the process whereby more labor is concentrated in industry as opposed to farming, which leads to greater consumption of natural resources to produce industrial goods.

industry: any large scale manufacturing or business activity involving the production of goods and/or services.

inference: drawing a conclusion based on evidence.

informal sanction: a penalty that acts to ensure compliance or conformity to a rule, law or custom based on social pressure as opposed to fines and jail sentences; examples include ostracization and ridicule.

inorganic: composed of matter other than that of plants or animals; most inorganic matter does not contain carbon, does not biodegrade and is derived from mineral sources.

interdependent: mutually reliant in living and working.

investigation: careful observation or search for information, done to gather evidence.

lake: an inland body of fresh or salt water.

landfill: often referred to as "sanitary landfill;" a place where refuse is buried, compacted and covered with soil. Sanitary landfills are often distinguished from dumps (or open dumps) and from secure landfills (landfills for hazardous wastes).

law: rules of conduct that are established in a democracy by citizens and their legislative representatives; sometimes given formal sanctions.

leachate: a liquid substance, often hazardous to nature, that forms in landfills as the result of rain or ground water percolating through waste matter; can be a threat to the quality of ground water used by households.

limerick: a light humorous or nonsensical verse of five lines usually with the rhyme scheme "aabba."

litter: human generated solid waste that is put in the wrong place or allowed to escape from a container.

location: a particular identifiable place; can be an area within a country or designated by national boundaries.

logo: a distinctive symbol identifying a particular thing, place or activity.

lyric: a poem or prose expressing emotions and thoughts, which is for singing in a light, flexible manner.

magnet: metal or stone that attracts iron and certain other materials through a force produced by the motion of atomic electrons and the alignment of atoms.

magnetic: having the properties of a magnet.

manufacturing: the process of making raw material into finished products, usually with the aid of machines.

map: a representation of an area of a community, state or larger region.

market: a gathering of people for buying and selling things; trade in a specific item or commodity such as aluminum or gold.

matter: what all things are made of; whatever occupies space and can be sensed or perceived by the senses.

measure: to find a distance or a dimension by using a device with designated marking in inches, centimeters, etc.

metals: elements such as iron, gold, aluminum which are obtained from ores in the earth; are malleable, ductile, shiny and good conductors of heat and electricity; alloys of these elements such as brass, bronze, etc.

metaphor: a figure of speech containing an implied comparison or analogy in which a term is transferred from the object it ordinarily designates to another object it may designate in order to help understand something.

mold: a hollow form designed to give a specific shape to something in a plastic or molten state.

narrator: one who tells a story or gives an account of something.

natural: present in or produced by nature; anything in our world not produced by humans.

natural resource: a material source of wealth, such as timber, fresh water, wildlife or a mineral deposit that occurs in nature.

necessary: needed to achieve a certain result or effect such as preserving food or protecting a product; based on our values as to what is essential.

need: a lack of something useful, required or desired.

news broadcast: a presentation of information on television or radio about recent happenings.

non-biodegradable: not capable of being broken down by biological processes.

noncombustible: not capable of being ignited or burned.

non-compostable: not appropriate for or not capable of producing compost; generally includes items which will not biodegrade.

nonferrous metal: metal not composed of nor containing iron, such as aluminum, copper and brass.

non-magnetic: not capable of being attracted by a magnet or magnetic field.

nonporous: a substance that will not allow fluids (or air) to pass through.

nonrenewable resource: a natural resource that cannot be renewed or regenerated except over very long periods of time.

norm: a standard of conduct regarded as typical for a specific group.

now: at the present time.

nutrient: a nourishing ingredient used in the growth and development of living organisms.

occupation: the trade, profession or business that enables a person to make a living; requires a certain type of education.

ocean: the entire body of salt water that covers about 72 percent of the Earth's surface; distinguished from freshwater lakes and rivers.

open dump: see "dump."

orbit: the path of a celestial body or human-made satellite as it revolves around another body.

organic: derived from living organisms or containing carbon compounds.

organic chemistry: the branch of chemistry dealing with materials and substances that contain or are made from carbon compounds.

overhead: the general costs of running a business, including rent, labor, materials and machines, maintenance and utilities.

packaging: covering, wrapper or container, often designed to attract purchasers as well as to protect a product.

paper: a thin sheet of material made of cellulose pulp, derived mainly from wood, rags, and certain grasses; used chiefly for writing, printing, drawing, packaging and covering walls.

paper pulp: a mixture of cellulose material such as wood, paper and rags ground up and moistened to make paper.

percentage: a part or amount in every hundred.

permeability: the ability to allow something, in particular a liquid, to pass through.

personal environment: all the objects, people, plants, animals and conditions in the surroundings of a person.

petroleum: a natural, thick, oily, flammable, dark liquid mixture found beneath the Earth's surface; used to make such products as natural gas, gasoline, lubricating oils, plastics, etc.

physical change: an alteration or transformation of the physical properties of a substance or material.

physical property: trait of a material or substance that when changed does not change its molecular structure, such as changes related to size or state of matter (solid, liquid or gas).

plastic: made from organic compounds such as petroleum that can be molded, cast, drawn, or laminated into objects.

pollution: the contamination of soil, water or air by the discharge or improper disposal of harmful substances.

porous: full of pores through which fluids (or air or light) may pass.

possible: capable of happening.

prefix: a word or syllable put before a word or stem to alter its meaning or create a new word.

price: the amount of money asked or paid for something.

process: a particular method of doing something, often in a logical sequential order.

processed materials: raw materials that have been extracted and refined in preparation for use in manufacturing.

production: the process of making or manufacturing a product for sale or trade.

profit: the money remaining after overhead costs have been subtracted from the money earned by sale of the product or service.

property (physical and chemical): the traits or characteristics of a substance determined by the senses or by the effect of another substance upon it.

public service message: an oral or written communication about a problem or action which can be taken.

purify: to rid something of impurities, to cleanse; particularly the filtering of water and air.

quality: any of the features that make something what it is and what it can be used for.

reconstruct: to construct again or make an object from usable parts.

recyclable: the ability to be used again to be made into a new or similar product.

recycle/recycling: to collect and process waste materials for use in manufacturing new products.

recycling center: a place where recyclables are collected, sorted and prepared for shipment to manufacturers.

recycling drive: an effort by a group of people or an institution to collect recyclables.

recycling plant: an industrial facility that uses recycled materials to make new products.

refuse: anything thrown away or rejected because it is convenient to do so or because it is thought to be useless; garbage and trash.

region: a large, usually continuous area characterized by particular plant and animal life and climate and topography.

renewable: capable of being replenished by a new supply or continual growth and development.

renewable resource: natural resources which can be renewed or regenerated by natural ecological cycles or sound management practices, e.g. trees and water.

resource: something that can be used to make something else.

reuse: to use again; to extend the life of an item by repairing it or by creating new uses for it.

reusable: capable of being used again either as is or by creating new uses.

reward: something offered in return for a particular service or behavior; can be used to motivate people.

rhyme: a poem or verse containing repetitions of sounds, especially at the ends of lines.

river: a large natural body of water that runs or empties into an ocean, lake, or other body of water.

rule: a regulation that has been made and accepted as a way of controlling behavior so that groups of people can get along or do certain things together.

rural: pertaining to the country, as opposed to the city.

sale: an exchange of goods by trading, using money or auctioning off items to the highest bidder.

sample: a part of something that represents or has the characteristics of the rest of the substance it was taken from.

sanction: a penalty for breaking the law that compels people to obey the law.

sanitation: the practice of keeping the environment clean and organisms healthy by the proper disposal of waste or the purification of water and air.

scale model: something that represents in a smaller size something else with all parts of the representation proportional to the original item.

scarce: not plentiful nor enough to meet demand.

scarce resources: natural resources of which there is a limited quantity compared with demand.

scavenger: any animal larger than a microorganism that eats decaying organic matter or refuse.

sequence: the order in which something occurs in a causally related series.

services: one type of offering a business may provide that involves doing something for people or providing something to people; contrasted with goods.

sewage treatment plant: a facility where liquid and solid wastes are treated and processed so that what remains may be returned to the environment safely.

shelter: something that provides cover and protection.

shred: to cut or tear into pieces or strips.

sign: something that presents information and/or pictures about a fact, public concern, quality of an item, method of solving a problem, etc.

simple machine: any of a variety of devices which make work easier such as a wedge, screw, lever, gear, inclined plane, pulley or wheel and axle; distinguished from compound machines such as a bicycle which includes two or more simple machines working together.

simulation: an activity designed to duplicate in a simpler way the actual activities and processes of a real life situation.

sink: to fall to the bottom.

slogan: a phrase expressing the aims or nature of an enterprise or organization; motto.

soil: the surface material on earth which includes clay, sand and loam or top soil, the latter of which is best for supporting plant growth.

solar system: the sun together with the planets and all other bodies that orbit the sun.

solid waste: regularly collected waste from households, institutions and commercial establishments.

solid waste management: planning and using various methods to dispose of solid waste, to reduce the quantity of waste, to recycle materials and/or to use waste material to produce energy or fuel. Also includes collecting and transporting waste.

sort: to separate objects from other objects based on special properties such as size, shape, color, etc.

sorting technique: a particular way to separate objects according to class, kind or size; often done with devices or machines.

source: point of origin; the natural resource from which raw materials come or from which they must be extracted and refined; typically includes plants and ores.

special event: an important happening that takes place on a particular date for a particular purpose.

steel: a hard, strong durable alloy made from iron and carbon; can be attracted by a magnetic force.

suburban: pertaining to a residential district on or near the outskirts of a city and often a separately incorporated city or town.

suffix: a word or syllable put at the end of a word or stem to alter its meaning or create a new word.

survey: a method of gathering information about attitudes, behaviors, historical events, etc. by using interviews and/or questionnaires.

symbol: something that stands for or represents something in real life; used to designate real objects on a map.

synonym: a word having the same or similar meaning to that of another word.

synthetic: produced by human means through chemical synthesis rather than of natural origin.

system: an arrangement of parts that interact to perform a specific function or functions.

task: a particular type of labor or undertaking assigned to a person which may be difficult and require special knowledge and skills.

technique: a method or manner of accomplishing something; used to motivate people to do something, e.g. behavioral technique.

then: at some time in the past.

tin: a silvery metallic element obtained chiefly from the ore cassiterite. It is used to coat other metals in products such as containers for food to prevent corrosion.

tinned steel: steel that is coated with tin.

town council: a group of people that represent citizens of a city or town assembled to make decisions or rules in the form of local ordinances.

trash: broken, discarded or worthless things, rubbish and other forms of refuse which are not food waste.

undesirable: objectionable, not pleasing or attractive, could be capable of harming living organisms.

unique: being the only one of its kind.

unnecessary: not needed to achieve a certain result.

urban: having to do with cities.

useful: having practical value.

variable: in an experiment, the factor which is changed to see what effect it has.

vegetable matter: consisting of or derived from plants, in contrast to animal or inorganic matter.

vocation: any particular type of labor a person does that is a trade or profession or occupation.

warning: something that makes you aware of potential or probable harm or danger.

waste: anything that is worthless or useless; material which cannot be reused or recycled and hence must be discarded or disposed of.

waste by-product: material or substance resulting from manufacturing processes which can often be reused or recycled or may have to be disposed of very carefully because of its hazardous nature.

waste crisis: a problem that must be dealt with as we run out of landfill space to bury refuse.

waste management: see "solid waste management."

water pollution: the contamination of rivers, lakes, oceans and groundwater by harmful chemicals and sewage.

water purification facility: a place where water is taken in and purified for drinking and other uses.

waterway: any body of water that is wide enough and deep enough to allow boats to pass through.

wildlife: animals living in a natural, undomesticated state.

wood: the tough, fibrous cellular substance of trees lying beneath the bark and consisting largely of cellulose and lignin.

work: something that is done by humans and/or machines that requires energy.

work place: a place where a person does things to make a living.

ANSWER KEYS

Answer keys are arranged alphabetically by the first word in the title of the handout (the activity title and chapter are given in parenthesis).

CALCULATING RESOURCE USE (**How Much Do We Use?** Ch. 5)

1. a. natural, b. renewable, c. resource;
2. 118;
3. 28 (12 divided by 3 = 4, 4x7=28); 112; (4x28=112)
4. 112 (If one 17′ tree = one 4′ stack and a 4′ stack = 112 newspapers, then one 17′ tree = 112 newspapers.)
5. About 1 or 1.05 (If 112 newspapers can be made from a 17′ tree and if one 17′ tree = 118 lbs. of newsprint, then 112 newspapers = 118 lbs. To find weight of a single newspaper, divide 118 by 112.)
6. 7 or 7.35 (1.05 X 7 = 7.35); 383 or 383.25 (1.05 X 365 = 383.25)
7. 3 1/4 or 3.25 (If one 17′ tree is required to make 112 newspapers, then divide 364 by 112 to get 3.25 trees.) To get the second answer multiply the number of families (represented by the total number of students) in the class by 3.25.

CAUSE AND EFFECT AND POLLUTION (**Deadly Drink,** Ch. 7)

1. Fish and plants can become sick or die because improperly treated sewage from sinks and toilets flows into streams, rivers and oceans.
2. Since wastes flow into the stream, the water in the stream is not safe to drink.
3. Rivers can become polluted if pesticides are washed off the land into them.
4. The factory was dumping chemicals into the stream, so fish and plants died.
5. Phosphates from detergents, when dumped into rivers, make algae grow rapidly.
6. As algae grow they use the oxygen needed by fish, so fish sometimes die.
7. Wastes buried in a landfill combine with water from rainfall to create a polluted mixture called leachate.
8. The underground water well became polluted when leachate seeped through the bottom of the landfill.

DECOMPOSING WORDS (**Compost Dwellers,** Ch. 3)

NO (bacteria can be considered non-green plants that can not make use of sunlight to make food)
1. psychro/philic; 2. meso/philic; 3. thermo/philic; 4. thermo/meter; 5. sapro/phytes

DESCRIBING HARMFUL WASTE (**Hazards And Waste,** Ch. 8)

1. noun
   a danger
   ous
   dangerous
2. verb
   to explode
   ive
   capable of exploding
3. verb
   to catch on fire
   able
   able to catch on fire
   e
   able
   ignitable
4. verb
   to wear away
   ive
   can wear away
   d
   e
   sive
   corrosive
5. noun
   something that can cause death (poison)
   ic
   able to cause death (poisonous)
   ic
   toxic
6. dangerous
   reactive
   ignitable
   corrosive
   toxic

DESCRIBING NATURE'S RECYCLING PROCESS (**Natural Recycling,** Ch. 3)

1. leaves
2. decomposers (bacteria, fungi); could mention small scavengers
3. a tree
4. scavengers and decomposers (students may list names of these)
5. a squirrel
6. scavengers and decomposers (students may list names of these)
7. nutrients being absorbed by roots

DON'T BREAK THE CHAIN (**Concentrated Chemicals,** Ch. 7)

1. Clover: The clover gets its energy from the sun.
   Rabbit: The rabbit gets its energy by eating the clover.
   Owl: The owl gets its energy by eating the rabbit, a herbivore.
2. Many possible answers but all should be related to the exposure of the clover to hazardous substances which have either leached into the soil (thus drawn up by the roots of the "producer" plants) or turned into gases in the air (thus drawn into plants by leaves). Leachate from solid waste dumps not properly managed or spills and leaks from hazardous waste dumps can be a source of ground pollution. Air pollution can be caused by incinerating waste or other materials such as coal.
3. They will have to migrate or find an alternative food source or they will die from starvation.

ENERGY RECOVERY (**To Burn Or Not To Burn,** Ch. 4)

1. Burning fuel heats water causing steam pressure to exert force to turn turbines. Turbines drive a generator to produce electricity to heat homes, play radios and TV's, cook food or for producing light.
2. coal, oil, gas, wood. Check to see if students list "garbage," or different materials found in garbage such as paper, cardboard, wood, plastic, etc.
3. Harmful gases and smoke are created. From observations in the experiment students should be able to deduce that some fuels produce less pollution than others. (Burning plastic creates lots of heat, but produces more pollution than burning paper. High sulfur coal creates more pollution when burned than other types of coal. Natural gas burns clean. Also mention that some fumes from combustion are invisible and can be toxic.)
4. A special filter device called a scrubber (or electrostatic precipitator) can be used to keep harmful smoke particles from escaping into the environment. See if students suggest ways to generate electricity without burning fuel, such as falling water, wind and solar cells. Nuclear reactions generate heat without burning matter, but require disposal of a very harmful (radioactive) waste by-product.
5. The energy used to make products that end up in the waste stream is "recovered" because many waste products contain stored energy which can be released upon burning.

GRAMMAR AND MECHANICS REVIEW (**Invasion Of The Pollutians,** Ch. 10)

1. The Wumps lived in a beautiful, unpolluted world.
2. "Help! Wump World is being invaded by the Pollutians."
3. The Pollutians threw litter everywhere, polluted the air with smoke and put waste in the water.
4. The Wumps moved underground to live.
5. What caused the Wumps to leave their world?
6. The Pollutians had almost destroyed Wump World with all the pollution.
7. There was only one grassy meadow left in Wump World.
8. The Pollutians decided to leave Wump World because it was so polluted.
9. "The Pollutians are gone," yelled the Wumps.
10. All of the Wumps worked together to clean up the pollution.

11. How did Wump World look now?
12. Some of the beauty began to return to Wump World, but it would never be the same.

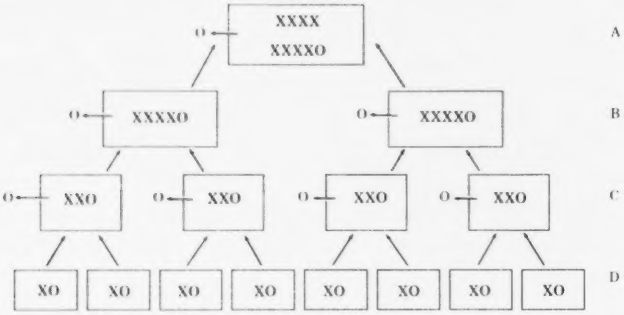
HAZARDOUS WASTE DISPOSAL ROUTES (**Hazards And Waste,** Ch. 8)

1. Two solid waste disposal routes are shown in the diagram; one leading from household containers to a landfill, another leading from a residential dumpster to an incinerator.
2. At a landfill, percolating water passing through waste material can turn into a hazardous substance called leachate. Leachate can work its way into aquifers if not carefully monitored and contained. See if any students were perceptive enough to suggest contamination of the aquifer. Incinerators can be the source of air pollution (dioxins) if chemicals, such as plastics and household hazardous waste, are not burned properly using filters. Landfills can be made safe by building a containment structure (of clay soil or plastic liners) to keep leachate from soaking deep into the ground. Pipes and pumps are often used to draw leachate out into special containment facilities. Incinerators can be made safe by burning waste at very high temperatures and by filtering out particles before emission into the air.
3. Students should be able to notice that pipes lead from household sinks to a sewage treatment plant. If something goes wrong at the sewage treatment plant, harmful waste may pass through it and be let out into the river. The street gutter leads directly into the river, therefore if someone puts a hazardous substance into it, the substance will go directly into the river.
4. The aquifer, as mentioned in the answer to question 2, could become polluted by leachate percolating through the dump into the ground around the aquifer. Also, if people pour hazardous waste or other chemicals on their lawns, these materials may also percolate down to water tables. A polluted aquifer can make people who drink water from it sick.
5. If sewage water from the house passes through the sewage treatment plant without being properly cleaned, then the water purification facility may take in this water to send to the apartment. The water purification facility is supposed to filter all drinking water before sending it to neighborhoods, but if something goes wrong or they do not detect a harmful chemical it may pass through the facility into the tap water of homes.

HOW LONG TO BIODEGRADE (**Decomposition Conditions,** Ch. 1)

First: piece of lettuce; second: piece of paper; cotton rag; unpainted wooden fence post; painted wooden fence post; tin can; aluminum can; plastic bottle; last: glass.

IT ALL ADDS UP (**Concentrated Chemicals,** Ch. 7)



PART A: aquatic plants; aquatic insects; fish; eagle.

LITTERING IN OHIO (**Ruling Out Litter,** Ch. 15)

1. b, c, e, g; 3. a; 4. a; 5. c, d; 6. b, c

LITTER LANES (**Map Out Litter,** Ch. 2)

1. trash lane; 2. 2; 4. landfill; 5. recycling boulevard; 7. recycling boulevard; 8. there are a lot of trash cans; 9. a trash can; 10. D-3 (E-6)/E-6 (D-3).

LITTER NEWS (**Time To Celebrate! But Wait!** Ch. 2)

1. a: hangover b: mountains of trash c: lots of debris
2. a: Ohio River shoreline b: downtown area c: sidewalks
3. fireworks display
4. 300,000
5. a: four mechanical sweepers b: hand crews

MUNCHING MICROBES (**Compost Dwellers,** Ch. 3)

1. WATER-FOOD-AIR; sunshine

2 & 3:

V [✓ APPLE CORE]
A [✓ DEAD FISH]
______ ALUMINUM CAN
V [✓ POTATO SKINS]
A [✓ WOOL RAGS]
V [✓ NEWSPAPER]
V [✓ APPLE WITH SKIN]

______ RUBBER TIRE
V [✓ LEAVES]
V [✓ COFFEE GROUNDS]
A [✓ FEATHERS]
______ GLASS JAR
A [✓ HAIR]
A [✓ DEAD BIRD]

A [✓ MANURE]
V [✓ SAWDUST]
______ PLASTIC BOTTLE
V [✓ BROCCOLI STALKS]
A [✓ LEATHER SHOE]
A [✓ LEATHER DUST]
V [✓ CORN COB]

4. water; helps breakdown and digestion

NATURE'S RECYCLING PROCESS (**Natural Recycling,** Ch. 3)

Sequence #1, picture 2 - both blocks are "K"
picture 3 - "J" in top block, "A," "B," "F" in bottom blocks
Sequence #2, picture 2 - "C" or "D," "E," "F"
picture 3 - "A," "B," "F"
Sequence #3, picture 2 - top blocks "D" and "E"
picture 3 - top block "I," bottom block "A," "B," "F"

NATURE'S SANITATION CREW (**Natural Recycling,** Ch. 3)

Part I: A & B are DECOMPOSERS; C, D, E, F are SCAVENGERS
Part II: G = 2nd, H = 1st, I = 3rd; J = 3rd, K = 2nd, L = 1st

RECYCLING MARKET VOCABULARY (**Dollars And Pounds,** Ch. 13)

PART A:
1. aluminum; 2. brass; 3. center; 4. copper; 5. demand; 6. glass; 7. gold; 8. litter; 9. paper; 10. recycle; 11. resource; 12. scarce.

PART B:
gold: a heavy yellow precious metal found in the earth
copper: a reddish brown metallic element found in the earth
aluminum: a light-weight, silvery metal made from bauxite
brass: a yellowish metal alloy of copper and zinc
glass: a hard, brittle material that can be seen through, made from sand and other materials
paper: a thin, flexible materials made from wood pulp

1. Paper is the only material made from a renewable resource. Glass, however, is made from a nonrenewable resource which is in abundance.

RESOURCE SIMULATION (**Resources & Conflicts,** Ch. 5)

1. Some resources are easy to obtain from the earth while others are buried in places that can make them difficult to find.
2. There are large and small deposits of resources.
3. Resources must be extracted from the earth and doing this often creates a lot of waste material, especially in mining activities where the pure raw material must be separated from other material found with it.
4. Resources are often used as fuel for energy to make other materials or to heat homes or provide electricity.
5. Resources can be conserved. Especially nonrenewable resources must be conserved if we are to have a lasting supply.
6. Different countries possess different quantities of natural resources or have more ability to obtain resources from others than do some countries.
7. Most all countries of the world must trade with other countries to obtain all the natural resources they need.
8. This would represent the renewing of a renewable resource.
9. This would represent the inability to renew a resource, hence it would be called a nonrenewable resource. These resources can be conserved by limiting consumption or by recycling.

SEQUENCING THE LIFE OF A NEWSPAPER (**Resources In The Life Of A Newspaper,** Ch. 5)

4; 9 or 10; 2; 8; 7; 9 or 10; 1; 5; 3; 6.

SEVEN SOURCES OF LITTER (**At The Source,** Ch. 2)

A. household garbage containers; B. loading dock; D. commercial; E. motorist; F. construction site; G. uncovered vehicle; H. pedestrian

SUBJECT-PREDICATE POLLUTION STATEMENTS (**Pollution Around The World,** Ch. 8)

1. Polluted water can harm animals and people.
2. Pesticides and herbicides can damage soil.
3. A big oil tanker may spill a huge load of oil into the sea.
4. A toxic spill from an overturned truck may force people from their homes.
5. The fish were killed by pesticide spills.
6. The average American throws away more than 252,000 pounds of garbage in a lifetime.
7. The Environmental Protection Agency estimates that there are over eighty thousand dumps with toxic waste in the United States.
8. Litter can harm plants and animals.
9. Waste products from power plants can be dangerous.
10. The fifth grade students helped pick up litter on the playground.

TIME ORDER OF A RECYCLING DRIVE (**Our School Recycles,** Ch. 13)

Our school recycling program begins on the first day of school. We begin studying about recycling and how it helps the environment. After studying about recycling we begin our advertising campaign. Our first "Recycling Saturday" is the first Saturday in October and will continue throughout the school year. From 9:00 to 11:00 am the elementary school is the collection center. People bring in their newspapers and aluminum cans at this time. At 10:45 am parent volunteers come to school and we load up their pickup trucks, vans and cars and depart to the recycling center. At the recycling center we unload and learn first-hand how recycling is done. We collect anywhere from $50.00 to $200.00 for our newspapers and aluminum cans.

TWO RECYCLING SYSTEMS (**Natural Recycling,** Ch. 3)

1. B, C; 2. A, D; 3. B; 4. C; 5. decomposers; 6. machines

UNDERSTANDING RECYCLING (**Magnets And Metaphors,** Ch. 4)

1. c; 2. d; 3. a; 4. b; 5. d; 6. a person or character telling a story; 7. making new clothes to wear from old material; 8. there are many possible answers: a wheel that goes around, painting an old house, etc.

WASTING WASTE: A PRE AND POST-TEST (**When They're Gone, They're Gone,** Ch. 5)

1. c; 2. b; 3. a; 4. c; 5. a; 6. c; 7. b; 8. c; 9. a.

WHAT MATERIALS? WHAT SOURCES?: (**The Original Source,** Ch. 5)

1. WOOD (Pulp): made from trees (sometimes other plants); (magazine, napkin, paper plate, cardboard).
2. GLASS: made from silica (sand), limestone (lime), soda ash; (mustard jar, syrup bottle, window, soda bottle, other possibilities)
3. PLASTIC: made from petroleum and coal; (two-liter soda bottle, 6-pack ring holder, candy wrapper)
4. ALUMINUM: made from bauxite and other chemicals; (pop can, beer can, foil, pie pan)
5. TINNED STEEL: tin is made from tin and steel from iron ore with other chemicals added; (soup can, door knob, tent stake)
6. CLOTH: made from plants (flax, jute), animals (sheep, silkworm); (sock, rag, possibly napkins)

"WHAT'S THE BIG IDEA?" (**The Alien Litter,** Ch. 1)

1. Litter consists of human-made materials and natural materials which are discarded improperly.
2. Natural litter is made of leaves, twigs and other once living objects which accumulate naturally and are useful to nature in some way.
3. We have a lot of power to help conserve our natural resources.

WHERE AND HOW? (**At The Source,** Ch. 2)

A. garbage and trash, including food and leaves, cans, bottles, wire, paper, cartons, boxes, automobile parts, furniture, glass and many other objects that are dropped on the ground or not contained properly; waste which is not contained (There are many possible variations in answers.)

B. a place where something begins; cause (of improperly contained garbage and trash)

1. loading dock; 2. motorist; 3. construction site; 4. household garbage containers; 5. uncovered vehicle; 6. pedestrian; 7. commercial.

WORDS AND THE AMERICAN LANDSCAPE (**This Littered Land Is Your Land,** Ch. 6)

1. B; 2. E; 3. B; 4. M; 5. M; 6. M; 7. B; 8. B; 9. E; 10. M; 11. B; 12. M; 13. E; 14. M; 15. M.

1. ISLAND; 2. DESERT; 3. LITTER; 4. REDWOODS; 5. POLLUTION; 6. FOREST; 7. RECYCLE

WORDS IN ORGANIC CHEMISTRY (**Recycling Plastic,** Ch. 4)

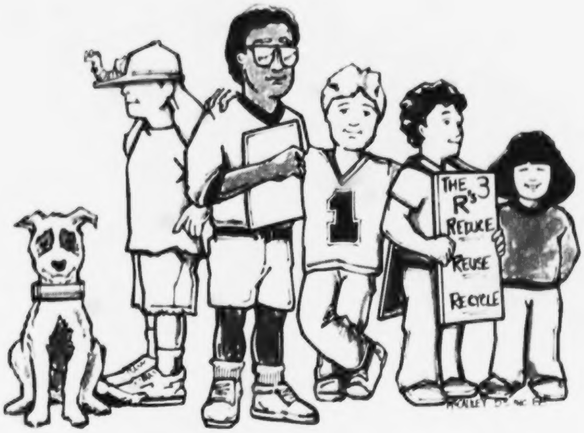
1. poly; 2. more than one, many; 3. many; 4. one; 5. -ene; 6. polystyrene; 7. very thick or compact; 8. not very thick, not compact; 9. garbage bag, compare the LDPE (Low Density Polyethelylene) garbage bag with the HDPE cup. The low density material stretches.); 10. Plastic materials such as ethylene, stryrene and propylene are types of materials made from petroleum. Petroleum is made from decayed plant and animal matter, hence organic matter.

WORDS TO KNOW (**Recycling Dramas,** Ch. 11)

1. recycling; 2. recycled; 3. conservation; 4. natural; 5. resources; 6. nonrenewable; 7. renewable; 8. land space.

INTRODUCING THE SUPER SAVER INVESTIGATORS TO STUDENTS

What Are Super Saver Investigators?



Mary John Richard Juan Kim

Super Saver Investigators are elementary age students who investigate waste management and pollution. They save the environment by:

a. disposing of waste properly;

b. reducing consumption of unnecessary materials;

c. reusing old materials;

d. recycling materials;

e. being informed and telling others about the relationships between improper waste disposal and possible harm to the environment.

Different Aptitudes Of The Super Savers

Five Super Savers are identified in this guidebook based on different interests and abilities. (This gives teachers a quick key to judging the nature of each activity as each activity includes an illustration of a Super Saver engaged in an educational act reflective of his or her talents and interests and also reflective of what students are to do in the activity.) The names of the Super Savers can be whatever students want to make them. For purposes of explanation below, names have been provided. (Note also that the Super Savers represent different ethnic backgrounds.)

Mary, who is Anglo-American, enjoys manipulating tools and equipment. She likes to make and use machines. She investigates how machines and technology can be applied to waste management and recycling, and she investigates the effects of the improper disposal of waste materials on wildlife and human health. She enjoys working outdoors.

John, who is Black-American, likes to conduct experiments and make mathematical calculations. He knows how to use scientific equipment and calculators. He generates hypotheses about waste disposal and recycling and tests these. He collects and organizes data about the consequences of improper waste disposal upon the environment. He figures how much money can be made by recycling and calculates quantities of resources used and saved by recycling.

Richard, who is Anglo-American, likes to read and write. He uses reference sources to look up information. He writes stories about what happens to waste when it is both properly and improperly disposed of. He makes charts to present information about recycling and saving resources. He conducts surveys to explain behaviors of people. He writes scripts and news stories to publicize and draw attention to waste problems.

Juan, who is Spanish-American, likes to take action and be a leader. He can motivate others to recycle and to take action to protect the environment. He enjoys organizing groups and he will stand up for what he believes without fear of peer pressure.

Kim, who is Asian-American, likes to create useful things from used materials. She enjoys classifying objects and making displays by cutt[illegible] and pasting. She writes songs to publicize issues. She enjoys working with her hands and manipulating objects and used materials to make art objects and crafts.

SUPER SAVER INVESTIGATORS ACTION-PICTURES EXERCISE

This exercise includes illustrations of the Super Savers and can be used however you like to introduce students to the Super Saver Investigators. Here are some suggestions:

- * Use the exercise before conducting any activities in the guidebook. You will need to explain some terms to students as you have them read the information sheet, **WHAT ARE SUPER SAVER INVESTIGATORS?** (You can become more familiar with these terms by reading the background information in the Introduction to this guide and to Chapters One and Two.) As students show interest in particular action-pictures more than others, you could record which ones they seem most interested in and plan to initiate activities related to these pictures. (You will find a listing of activities from which each picture was taken at the end of this section. You can also use the **Learning Skills Index** to identify other activities that include similar skill development exercises for students.)
- * Proceed as suggested above, but first introduce students to the subject of waste management by conducting one or more activities from Chapters One and/or Two.
- * Use this exercise (after conducting all activities you wish to do) as a way of evaluating what students have learned. Note that the last illustration handout, **Message Pictures**, requires a different procedure than the other handouts, which makes it valuable as a general evaluation tool.

Using The Action-Pictures

After deciding which approach to use above, conduct the exercise in the following manner:

a. Have students read the handout, **WHAT ARE SUPER SAVER INVESTIGATORS?** and discuss.

b. Go over the instructions for using the action-pictures as described for students in the handout, **WHAT ARE SOME THINGS YOU CAN DO TO INVESTIGATE AND TO SAVE THE ENVIRONMENT?**

c. Have students complete the exercise using the action-pictures. Remember that the illustration handout, **Message Pictures**, is used in a different way, which may make it more appropriate as an evaluation tool.

WHAT ARE SUPER SAVER INVESTIGATORS?

THE 3 R's
REDUCE
REUSE
RECYCLE
1

Super Saver Investigators are students just like you and your classmates. To be a Super Saver Investigator you must care about the environment. The environment includes everything around you such as land, rivers, trees, soil, animals, buildings and people.

If you investigate your environment, you will find that people often do things that harm or degrade the environment. Sometimes people litter, which can hurt animals and other people. Sometimes garbage is taken in trucks and dumped in places where it can pollute water and hurt animals living in or near the polluted water. Sometimes people can be harmed by drinking polluted water.

If you investigate your environment, you will also find that people throw away things that can still be used. Glass bottles, newspapers, aluminum cans and motor oil are a few of the items people throw away which can be used again by recycling. Recycling means to make new things from old things people would otherwise throw away. When new glass bottles are made from old bottles, this is recycling. Similarly, when new newspapers are made from old newspapers, when new aluminum cans are made from old aluminum cans, when new motor oil is made from old motor oil, these are examples of recycling.

If you investigate recycling, you will find that when people do not recycle, more natural resources must be taken from the earth to make new products. For example, aluminum cans are made from aluminum ore, which must be taken from the earth. If we do not recycle old aluminum cans, we must take more ore from the earth to make new ones. And when more ore is taken from the earth, more oil and gas are also taken from the earth to run machines that are used to dig ore out of the earth. So recycling saves natural resources and also energy.

To be a Super Saver Investigator you must investigate what happens to waste materials in the environment. Then, based on what you learn from your investigations, you must act to save the environment.

WHAT ARE SOME THINGS YOU CAN DO TO INVESTIGATE AND TO SAVE THE ENVIRONMENT?

Look at the series of pictures of the five Super Saver Investigators. Each picture in each series shows one of the Super Savers doing something to investigate or to save the environment. See if you can identify what each Super Saver is doing in each picture. Some of the things they are doing are listed below, but you might think of other things they are doing as well.

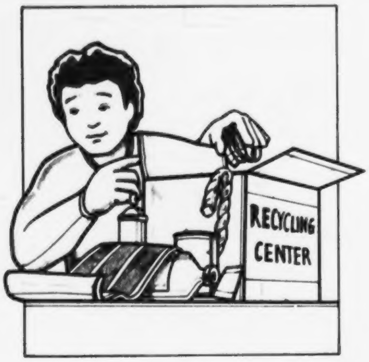
Doing an experiment
Making mathematical calculations
Telling others what they can do
Writing reports
Doing research
Making tools
Looking closely at nature
Making artistic objects

As you describe what each student is doing in each picture tell why they are doing what they are doing. For example, a Super Saver might be doing an experiment to see if water has been polluted by garbage. Or, a Super Saver might be doing research to find out what resources are being saved by recycling.

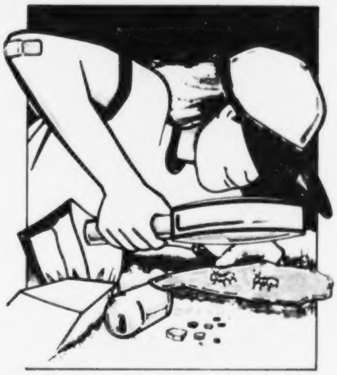
Directions: For each lettered picture, describe on line 1 what you think each Super Saver Investigator is doing, and on line 2 tell why they are doing what they are doing.

INTRODUCING THE SUPER SAVER INVESTIGATORS

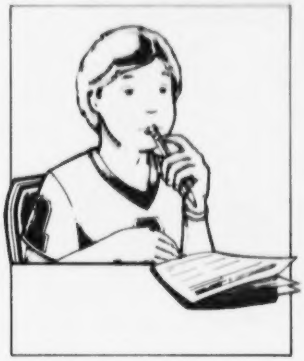
Action-Pictures **Series 1**


RECYCLING
CENTER

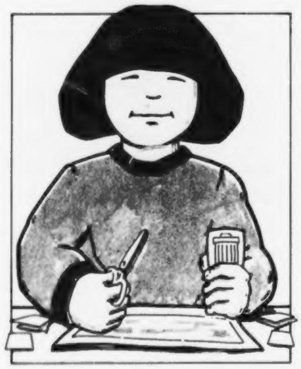
A



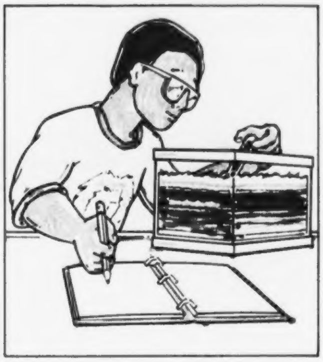
B



C



D



E

A 1 ______________________________

2 ______________________________

B 1 ______________________________

2 ______________________________

C 1 ______________________________

2 ______________________________

D 1 ______________________________

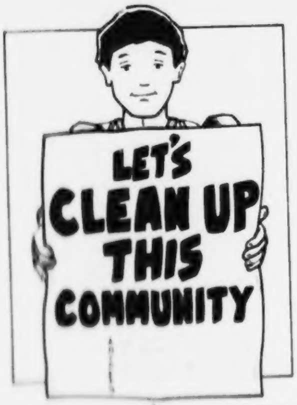
2 ______________________________

E 1 ______________________________

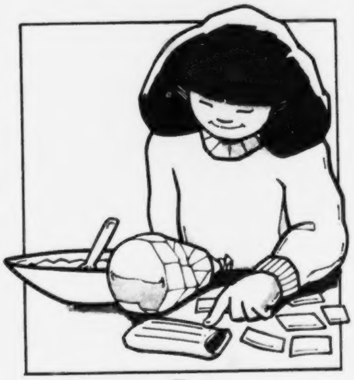
2 ______________________________

Action-Pictures

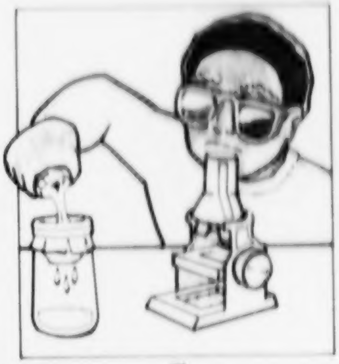
Series 2


LET'S
CLEAN UP
THIS
COMMUNITY

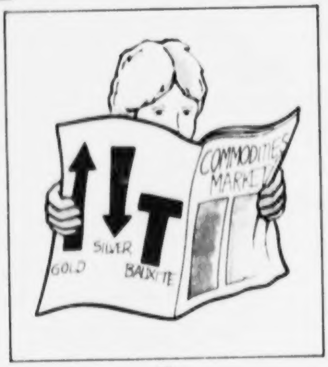
A



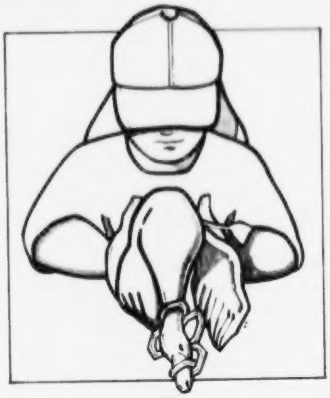
B



C


COMMODITIES MARKET
GOLD
SILVER
BAUXITE

D



E

A 1 ____________________

2 ____________________

B 1 ____________________

2 ____________________

C 1 ____________________

2 ____________________

D 1 ____________________

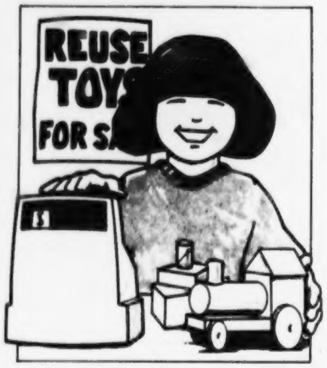
2 ____________________

E 1 ____________________

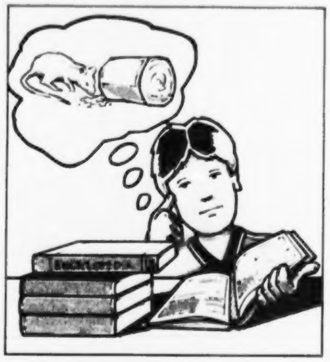
2 ____________________

Action-Pictures

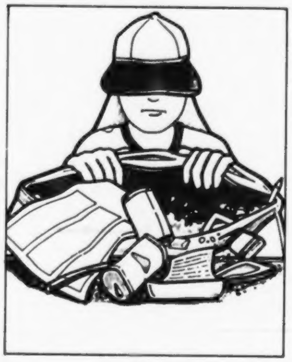
Series 3


REUSE
TOYS
FOR SA
$

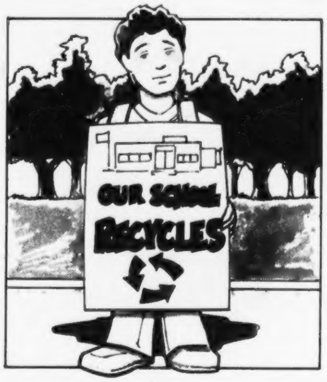
A


ENCYCLOPEDIA

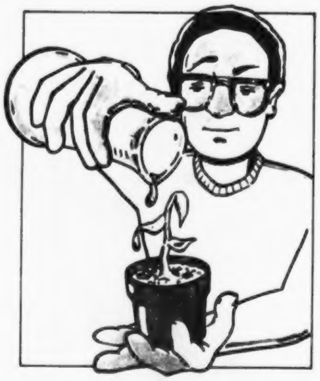
B



C


OUR SCHOOL
RECYCLES

D



E

A 1

2

B 1

2

C 1

2

D 1

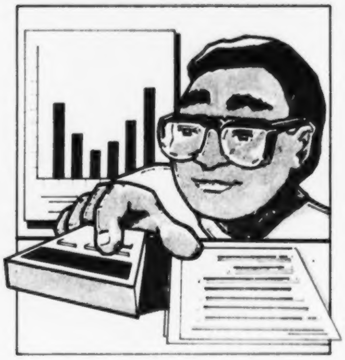
2

E 1

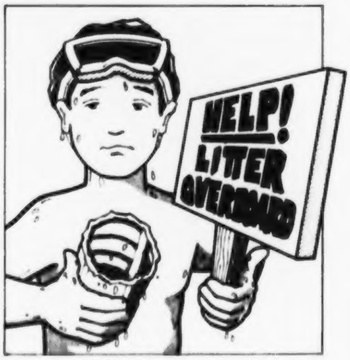
2

Action-Pictures

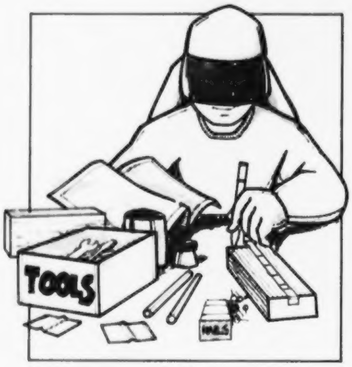
Series 4



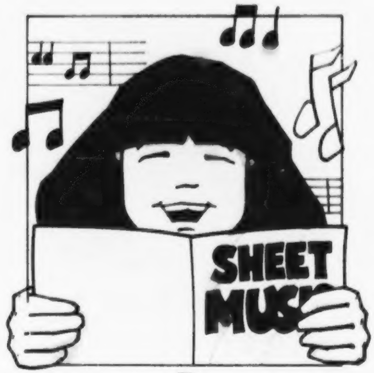
A


HELP!
LITTER
OVERBOARD

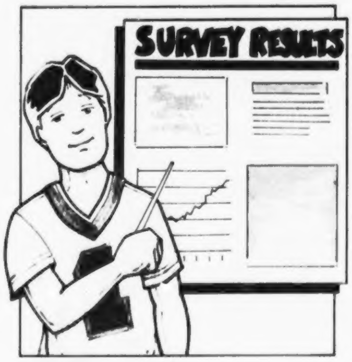
B



C


SHEET
MUSIC

D


SURVEY RESULTS

E

A 1 ____________________

2 ____________________

B 1 ____________________

2 ____________________

C 1 ____________________

2 ____________________

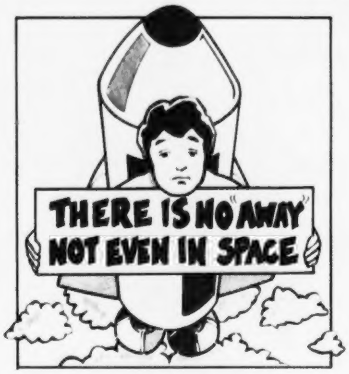
D 1 ____________________

2 ____________________

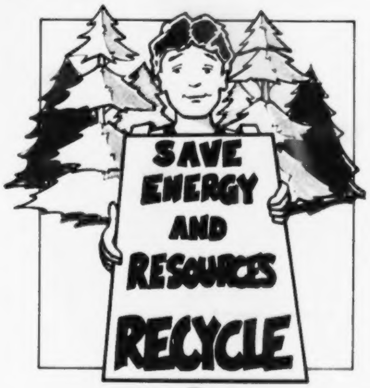
E 1 ____________________

2 ____________________

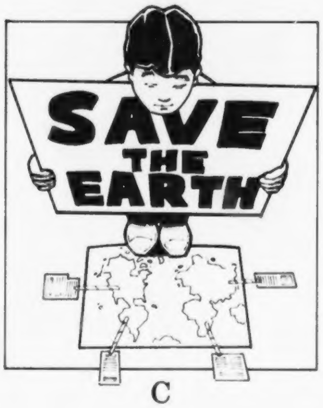
Message Pictures


THERE IS NO "AWAY"
NOT EVEN IN SPACE

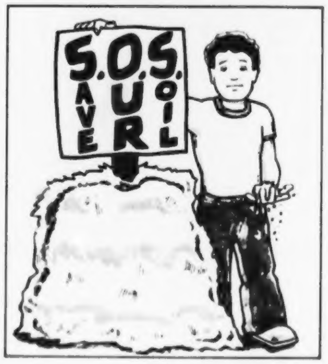
A


SAVE ENERGY AND RESOURCES
RECYCLE

B


SAVE THE EARTH

C


S.O.S.
SAVE OUR SOIL

D

Directions: Explain the meaning of each action message and tell why the message in each picture is important.

A

B

C

D

ACTIVITY TITLES MATCHING PICURES USED IN THE ACTION-PICTURES EXERCISES

ACTION-PICTURES SERIES 1	CHAPTER	ACTION-PICTURES SERIES 2	CHAPTER
A. Useful Waste	(1)	A. At The Source	(2)
B. Alien Litter	(1)	B. Puppet Dramas	(11)
C. Waste & Words	(6)	C. Is The Water Fit To Drink?	(8)
D. Map Out Litter	(2)	D. Dollars And Pounds	(13)
E. Tiny Beastie's Feast	(3)	E. How Did This Happen?	(7)
ACTION-PICTURES SERIES 3		**ACTION-PICTURES SERIES 4**	
A. Recycleville, USA	(12)	A. How Much Do We Use?	(5)
B. Shabby Shelter	(8)	B. What's Under Water?	(7)
C. Waste In The Workplace	(2)	C. The Great Can Crusher Contest	(14)
D. Our School Recycles	(13)	D. This Littered Land Is Your Land	(6)
E. Deadly Drink	(7)	E. Trash In History	(9)

MESSAGE-PICTURES	CHAPTER
A. Waste In Space	(6)
B. Resources In The Life Of A Newspaper	(5)
C. Pollution Around The World	(8)
D. Compost Dwellers	(3)

Chapter 1

The Matter of Waste

THE MATTER OF WASTE

CHAPTER 1

What are we throwing away?

What we throw away includes many materials. Familiar words such as *garbage, refuse, rubbish, trash* and *scrap* refer to different kinds of waste materials. ***Garbage*** is food waste including animal and vegetable matter from kitchens, restaurants, grocery stores, slaughter houses and food processing plants. Other waste, including garbage, is called refuse. ***Refuse*** can be many things: ashes, food waste, packaging materials, cans, stones, glass bottles, dead animals, abandoned cars, construction site materials and sewage treatment residues. ***Rubbish*** and ***trash*** are waste minus garbage. ***Scrap*** is rubbish or trash in the form of fragments or large bulky junk items such as old refrigerators, old automobiles, old ships or parts of these. All of the waste materials described above make up what is known as ***solid waste***[1]. Solid waste is usually distinguished from hazardous waste produced from industry. However, some solid waste from households contains potentially hazardous substances.

A ***refuse analysis*** is a way of classifying different waste materials by weight or volume. The following list shows typical kinds of waste often referred to as ***municipal solid waste***, that result from human activity in homes, schools, offices and businesses (but not on farms or in industry). The following municipal solid waste analysis[2] is based on percentages (by weight) of the components:

PAPER (various types, including cardboard)		42.1%
YARD WASTES (leaves, grass, street sweepings)		16.1%
GLASS (and ceramics)		9.4%
METALS		9.2%
Ferrous	7.6%	
Aluminum	1.4%	
Other non-ferrous (brass, copper, zinc)	0.2%	
FOOD WASTES (garbage)		7.3%
PLASTICS (packaging, housewares, toys, furniture)		6.5%
WOOD (packaging, furniture, toys, twigs)		3.4%
RUBBER (synthetic and natural) and Leather		2.3%
TEXTILES (synthetic and natural)		1.9%
ASHES, DIRT, MISCELLANEOUS		1.8%

The materials in a refuse analysis can also be classified by properties of matter. A typical analysis of this sort is as follows: non-combustibles, including metals and glass (24%); organic food waste, including garbage and fat (12%); combustibles, including paper, plastic, cloth, rubber and wood (64%).[3] Municipal solid waste analyses do not usually include larger sources of scrap such as automobiles, trains and ships although these are also part of the solid waste disposal problem.

Containers and packaging materials make up an important category of waste which represents some 30% of municipal solid waste. Consider the variety of packaging for consumer products purchased weekly at the store:

PAPER: paper bags, wrapping paper and wax paper, cartons and cardboard boxes, candy wrappers of cellophane and cellulose;

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[1] According to the Resource Conservation and Recovery Act of 1976, *solid waste* is defined as follows: "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded materials, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits." *EPA Activities: Under the Resource Conservation and Recovery Act of 1976, Annual Report To The President and Congress* (The Office of Water & Waste Management, U.S. EPA, March 1979), p. 1-1.

[2] "Characterization of Municipal Solid Waste In the United States, 1960 to 2000," (Franklin Associates, Ltd., 1987). Refuse analyses differ statistically because of numerous variables and different types of measurement designs. However, the relative differences of quantities among the types of waste materials in any one analysis are generally the same as in other analyses. For example, paper is always the largest quantity of any item, followed by yard waste, while glass and metals amount to less but more than plastic, wood or rubber items.

[3] R. Fred Rolsten, "Solid Waste! Is It a Waste?" *Materials: dispose or recycle?* (The Wright Company, 1976), pp.3-4.

WOOD/CLOTH: sacks for grain and seed, wooden cases for fruit, string;
METAL: food in tinned steel cans, soft drinks in aluminum cans, foil, aerosol cans;
GLASS: jars and bottles to preserve peanut butter, olives, mustard, soft drinks and many more items;
PLASTIC: bottles of polyethylene and polyvinyl chloride for soap and shampoo, packaging for radios from expanded polystyrene, plastic bubbles protecting toys, plastic wrap for meats and produce.

Packaging increases the amount of waste requiring disposal and is a significant part of the cost of products we buy. Packaging is often necessary to preserve and protect products, but examples of unnecessary packaging also abound.

Reduce and Reuse

There are two important ways to diminish the amount of waste requiring disposal and to save resources as well: reduce and reuse materials. People can ***reduce*** their consumption of materials at home, at school and at work. This can be done by using only necessary quantities of materials and by buying products that are not unnecessarily packaged. Waste material requiring disposal can also be reduced by buying materials that are easily recycled. ***Reuse*** often requires creative, resourceful ideas for making new or decorative objects out of the parts and materials of discarded items. Elementary teachers have been reusing materials for quite some time in their search for economical and creative classroom projects.

Recycling and Saving Resources

Waste is often perceived as having little or no value. However, much of what people in the United States throw away as ***waste*** is really ***useful***. The distinction between what is truly waste and what is useful is very important when considering how we can save resources and energy and how we can save scarce landfill space. It is well established that Americans waste billions of dollars per year in energy and materials that could be useful. Much of this waste of waste happens by failing to transform or ***recycle*** materials such as glass, iron, aluminum and other nonferrous metals into new products that are again useful. According to one calculation, "over 80% of the solid wastes produced in the United States are disposed of by landfilling; 10% are incinerated; and only 5% are recycled."[1]

Resources reclaimed through recycling can be either renewable or non-renewable resources. ***Renewable resources*** are alive or continually being produced in the natural environment, thus they regenerate. Renewable energy resources include the sun, wind and ocean waves. Renewable material resources include trees, animals and food crops. (It *is* possible, however, for human beings to interfere with the balance of nature and cause shortages or even the extinction of renewable resources.) ***Non-renewable resources*** are non-living. These resources are considered non-renewable because they were created by biogeological processes taking thousands or millions of years. Non-renewable energy resources include fossil fuels such as coal, oil and natural gas. Non-renewable material resources include iron ore, copper, sand and limestone.

Many materials thrown out as waste are made of non-renewable resources and require non-renewable energy resources to be produced. This makes recycling these materials especially beneficial. Products manufactured from recycled materials usually require fewer virgin resources and less energy to make. Human recycling imitates nature's own process of recycling by conserving energy and natural resources. This is done, as in the natural environment, by breaking down and rebuilding the physical (and sometimes chemical) properties of recyclable materials.

Obstacles to recycling involve several factors: the way products are made; economic and social factors; and technological inadequacies. Items that are difficult to recycle include certain plastics, bimetal cans, aerosol spray containers, plastic coated paper and food packaging containers (including wrappers) which are made of a combination of materials such as paper and/or plastic and/or foil. These are difficult to recycle because their constituent materials must be separated and recycled individually, which can be very expensive to do. Another factor inhibiting recycling is the lack of markets for recycled materials. One of the goals of the Ohio Division of Litter Prevention & Recycling is to identify existing and potential markets for recycled goods.

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[1] "Lesson 1: Landfill Course Introduction," *Waste Age* 17 (January 1986), p. 6.

Understanding Waste and the Disposal of Waste

Waste is constantly being generated and it does not cease to exist once it is discarded. The law of the conservation of matter applies as directly to waste as to any other substance. Discarded wastes do not disappear and are not destroyed, but can be transformed into other substances and materials. How waste is transformed is dependent on many factors. These include characteristics of the waste itself, external environmental conditions affecting the waste, and how waste is managed by people.

Transformation of matter takes place at different rates and in different ways based on the physical and chemical properties of different materials. Some materials such as glass and plastic are so durable that they hardly change at all and could be dug out of a landfill intact 2000 years from now. Paper products, on the other hand, generally decay quickly. The environmental change process of waste materials is called ***decomposition***. The decomposition of materials can result from biological action, from weathering processes or from chemical changes. Any material is considered ***biodegradable*** if it can be broken down into basic elements by normal biological processes. For example, paper products, wood and garbage are capable of being broken down biologically by microorganisms such as bacteria and fungi. However, materials such as glass, plastic and aluminum are ***non-biodegradable*** because bacteria and other decomposers cannot break them down, or cannot break them down easily. Non-biodegradable materials are susceptible to breakdown by weathering and chemical changes.

Weathering is a process of decomposition caused by temperature changes, rain, wind and sunlight. Another way some non-biodegradable materials decompose is through ***oxidation***, a chemical change associated with the decomposition of metals. Rusting is the result of the oxidation of iron. Not all metals oxidize at the same rate; aluminum takes longer than tin or steel.

The distinction between organic and inorganic waste materials is another distinction important for understanding decomposition processes. Most solid waste materials that are organic decompose more rapidly than inorganic materials. ***Organic*** waste materials are made or gathered from living animal or vegetable matter. Organic wastes such as food remains and paper products decompose quickly. However, other organic waste materials, such as rubber and plastic can take a very long time to decompose. (Plastics and rubber are made from petroleum, an organic material which derives from once-living organisms which have decayed over a period of thousands of years.) ***Inorganic*** waste materials such as steel, glass and aluminum are derived from nonliving things and take a relatively long time to decompose. For instance, glass that is over a thousand years old has been dug up by archeologists. Inorganic waste contains matter that is not broken down easily by weathering or biological processes.

Human-made products, whether they are derived from organic or inorganic materials, take longer to decompose than ***natural*** objects such as plants and animals. Observations of the physical properties of matter help to distinguish human-made objects from natural objects. Compared to natural objects, human-made objects tend to be brighter, more lustrous, smoother, more precise and uniform in size, weight and shape, and have less smell. Physical characteristics also indicate the functions objects served before they entered the waste stream. These functions may have included durability, convenience, storage and preservation, warmth and comfort. In order to produce products that serve these functions, we have made materials that cause problems when we throw them away.

Landfills and What Happens to Waste in Them

A ***landfill*** is where most of our waste is taken to be buried in the ground. Landfilling waste can be an environmentally sound way to dispose of waste. Modern landfills are not the noxious open dumps of the past. At a landfill, waste materials are spread out and compacted in layers by machines. These layers are then covered with earth at the end of each day. This keeps vermin, diseases, blowing materials, odors and human-caused combustion from being a problem to nearby residents. At a landfill, as successive layers of compacted waste and earth build up to several feet (10-12 is typical), these are completely covered (typically in a ratio of one part soil to four parts waste) to make a *cell*. Cells are built beside and on top of each other until they reach as much as 50 to 100 feet above the original ground surface. A final covering of two to five feet of soil (that may include a layer of clay underneath to keep water out) is then put in place. Vegetation is established on top.

In some cases parks are even created on top of landfills.

Simply covering waste materials with dirt does not make a landfill environmentally safe. Landfills (which are also called *sanitary landfills*) must be engineered to remove all harmful liquids and harmful gases which eventually arise. This requires lining the bottom of the landfill with special materials and installing pipes to collect hazardous gases and toxic liquids. Numerous ***household hazardous wastes*** (poison, bug spray, shoe polish, etc.) end up in landfills without being treated beforehand. This means a landfill contains different chemicals from containers, which together with rain water and acids generated by bacteria produce a harmful liquid called ***leachate***. Another harmful element is a dangerous gas, known as ***methane***, which is eventually produced at landfills after some years. The contents of a landfill can be viewed as a mass of teeming life, liquids and gases interacting to create biophysical transformations as the garbage and trash we throw away decomposes.

Both theoretical and technical sciences are applied in managing solid waste disposal at a landfill. Properly maintained landfills involve complex designs and each one is different because of the many variables and theories associated with the construction of a landfill. A brief consideration of a few variables will give some insight into the theoretical and experimental nature of landfill construction. The variables considered can be described according to two categories: environmental factors and properties of waste materials.

In considering environmental factors, several variables can be identified. They include moisture and rainfall, temperature, compaction of soil and soil cover permeability. For example, the more moisture in a landfill (which is determined by rainfall and soil permeability), the less air circulates. This limits certain types of bacteria which decompose organic matter quicker than bacteria which thrive without oxygen. Other variables to consider include the right mixture of air and moisture in a landfill, or variations in temperatures that affect the rate of decay of materials.

In regard to the properties of waste materials, one important variable is the ability of a waste material to decay in the presence of biological or chemical elements. Garbage (organic food remains) decompose very rapidly, as aerobic bacteria (bacteria requiring oxygen to live) and other tiny organisms in the soil begin to feed on the waste. Paper is also decomposed relatively quickly by bacteria and fungi depending on the grade and type of paper product. Natural cloth and wood are consumed at a slower rate by microorganisms. As microorganisms consume waste, they incorporate elements of waste materials such as ammonia, carbon, phosphorus and potassium into microbial protoplasm. Oxidation replaces microorganisms as the decomposing agent of metals and minerals in natural fibers and other products. Oxidation of some materials, however, creates toxic oxides, which can create pollution problems. Synthetic rubber remains essentially inert, while natural rubber breaks down extremely slowly. Glass and plastic are also inert in landfills.

Other variables related to the properties of waste materials include their ability to be compacted or shredded or to become hazardous to life. Waste materials which can be shredded or baled save space in a landfill. Rocks, clean dirt, bricks, concrete and crushed glass compact well and cause no pollution. Items such as tires, mattresses, furniture and appliances compact and settle poorly as they take up a lot of space and move around in landfills.

An increasingly important problem is the disposal of household hazardous waste by consumers. Chemicals, paints, insecticides and other household hazardous waste can leach into ground water supplies and pollute the environment outside a landfill if leachate is not properly contained. Hazardous wastes are often difficult to recycle, but treating them before disposal can help to keep them from being harmful when taken to a landfill. However, some household wastes, which are considered very toxic, should be taken to special waste disposal facilities. Consumers can be especially helpful in a comprehensive solid waste management program by recycling materials such as paper, glass, aluminum and plastic and by disposing of hazardous wastes properly.

USEFUL WASTE

CHAPTER **1**

RECYCLING CENTER

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *identify and describe* waste material in their environment; (2) *compare* items of waste which can be useful when reused or recycled with items of waste which must be disposed. Students will improve their abilities to *express thoughts orally and in writing.*

Method

Students discuss the difference between useful objects and waste objects; they *reason* and *rank* a variety of waste items from "most useable" to "least useable." They discuss recycling and *classify* waste items brought from home as recyclable, reuseable or disposable.

Duration: two to three class periods.

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 2.2, 6.1

Preparation

Gather the following items: aluminum can (half crushed), glass bottle, crumpled page of newspaper, plastic bottle (creased or dented), tin can, cigarette butt, piece of rope, orange peel, bottle cap and an empty aerosol bug spray container or other household hazardous waste container. If you can, put sets of these items in bags, with enough bags for each group, if you decide to use groups.

Vocabulary

hazardous waste, landfill, litter, recyclable, useful, waste

Handout

Rating Waste

Procedures

1. Decide whether you want this activity to be accomplished individually or in small groups. If you choose the latter, divide the class or have them choose their own groups.

2. Arrange the items listed below on a demonstration table, or, if you made provisions to do so, give a set of items to each group and have students arrange items on tables so they can be seen and touched. Write the name of each item on the board. (Do not list in the order below as this list is divided into items which are typically recyclable and items which must usually be thrown out, a distinction relative to a later exercise for students.)

   ALUMINUM CAN
   GLASS BOTTLE
   PAGE OF NEWSPAPER
   PLASTIC POP BOTTLE
   TIN CAN

   CIGARETTE BUTT
   PIECE OF ROPE
   EMPTY BUG SPRAY CAN
   ORANGE PEEL
   BOTTLE CAP

   Discuss how these waste objects were once useful and how they often end up as litter or in trash cans. Define the terms "litter," "useful" and "waste". Do not mention recycling at this point unless it is brought up by students.

3. Instruct each student or group of students to rate each item from the "most useable" to the "least useable" object. Groups can arrange items in rank order across the table. Have students present their reasoning in each case. The handout, ***Rating Waste***, is to be used for this purpose when dealing with older students. (Reasoning might include the use of the object to make something or to keep something in. Items could be used as tools or in a game. In some cases, aesthetic ugliness, threats to health or injury potential might affect judgments about an

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object's usefulness. Some students may reason based on recycling potential or even use in composting.) When completed, discuss answers with the class.

4. Discuss the concepts of reuse and recycling. Explain that objects which can be reused or recycled are useful. Go over each item again and discuss whether it is recyclable (useful) or a waste object. Those objects in the left column above are recyclable; those items in the right column usually end up being thrown away. But there is no definite answer, as someone could reuse an item such as a orange peel in a compost pile. Some students may suggest that bottle caps and rope could be reused as art projects. Check and see if any of the recyclables you have discussed are collected in your community so you can tell students about recycling opportunities available to them. Or, start a recycling drive at your school.

5. Ask students which item could be hazardous to their health (bug spray). Explain what hazardous means.

Evaluation Have students check to see what has been thrown away at home. Ask them to bring in one clean waste item, one clean recyclable item and a clean reusable item. When students bring these to class, have them put each item in different boxes explaining why they are doing so. Mark the box for recyclable items "Recycling Center" and the one for waste items "Landfill." Explain how reusing and recycling waste saves landfill space. Explain why we need to save scarce landfill space.

RATING WASTE

Directions: Rate items from the **MOST** useable to the **LEAST** useable. Write them down in rank order in spaces 1-10. Write down the reasons why you chose the first three items to be most useable and the last three items to be least useable.

MOST USEABLE

1. ______________________ Reason: ______________________

____

2. ______________________ Reason: ______________________

____

3. ______________________ Reason: ______________________

____

4. ______________________

5. ______________________

6. ______________________

7. ______________________

8. ______________________ Reason: ______________________

____

9. ______________________ Reason: ______________________

____

10. ______________________ Reason: ______________________

____

LEAST USEABLE

NATURAL RESOURCES AND WASTE MATERIALS

CHAPTER 1

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *classify* waste according to environmental distinctions such as natural or human-made, organic or inorganic, made from renewable or made from nonrenewable resources; (2) *explain* how recycling saves natural resources. Students will improve their ability to *describe similarities and differences.*

Method

Students identify objects on a handout as either natural or human-made. They identify litter on the handout and *infer* what natural resources were used to make the human-made objects. They make a collage to reinforce the learning of distinctions covered in the activity.

Duration: two to four class periods

Setting: classroom

Subjects: Science, Arts & Crafts

Curriculum Reference: 2.2

Preparation

Gather materials to make a collage: crayons, magazines, scissors, chart paper (or poster board), glue or thumb-tacks. Gage the learning abilities of your students as the later activities in the **Procedures** and in the **Evaluation** are more difficult assignments than the initial exercises.

Vocabulary

biodegrade, classify, collage, human-made, inorganic, litter, natural, nonrenewable resources, organic, recyclable, renewable resources

Handout

Natural or Human-Made? Answer Key

Procedures

1. Ask students what the words "natural" and "human-made" mean. Natural things include all living things (plants and animals) and objects of the earth (rocks, soil, sand). Human-made items are things people make, often with tools and machines. Have an assortment of these items on hand to show the class, but avoid using items on the handout, ***Natural or Human-Made?***
2. Give a copy of the handout, ***Natural or Human-made?*** to each student and have them complete it according to instructions. Discuss after they complete it.
3. Have students identify human-made objects represented as litter in the handout and the "natural litter" (apple core on sidewalk). "Natural litter" in this context refers to a natural object littered by someone. Explain how natural litter can cause harm in a human environment while it can be useful in a natural environment. In a human environment it could cause an accident or attract vermin with disease. It will biodegrade and become part of the nutrients in soil in a natural environment. Compare human reuse or recycling of human-made objects to natural recycling of organic wastes.
4. If using this activity with older students, define the terms "organic" and "inorganic," "renewable resources" and "nonrenewable resources" and "recyclable." Look at the handout again. Have students identify the natural organic items and the natural inorganic items. Then have them point out which of these natural items are renewable resources and which are nonrenewable.
5. Ask students to draw a line (or lines) from each of the human-made objects to the resources (nat-

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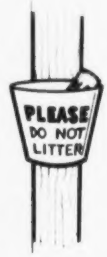
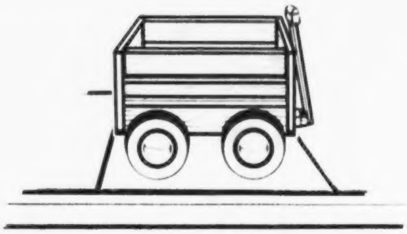
ural objects) used to make them. Have students identify which human-made objects can be recycled and thus which natural resources are being saved by recycling. Ask students to identify the one object depicted on the handout which is the natural source of all other objects on the handout (sun). Explain.

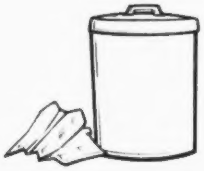
Evaluation Pass out magazines with pictures and advertisements. Have each student cut out a picture of a human-made item and a picture of a natural item. Put two large sheets of paper on the bulletin board, marking one "human-made" and the other "natural." One at a time, have each student bring up a natural and a human-made picture to be affixed to the appropriate poster in collage fashion. As each student brings up the pictures, discuss with the class if the pictures have been categorized correctly. For older students, after completing the two collages, have them identify each picture according to the following classifications: a. organic object; b. inorganic object; c. recyclable object made from renewable resources and d. recyclable object made from nonrecyclable resources. They could make a list of these on paper.

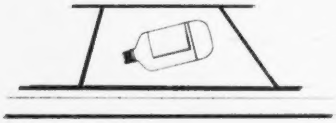
NATURAL OR HUMAN–MADE?

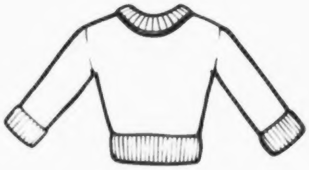
Directions: Circle the pictures of human-made objects. Outline in pencil or crayon the pictures of natural objects or substances. Put an "X" on the littered objects.

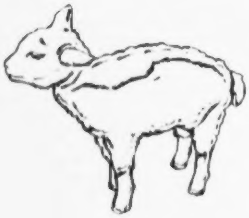


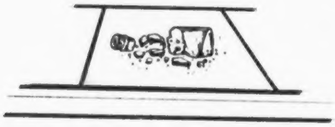


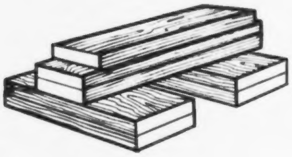


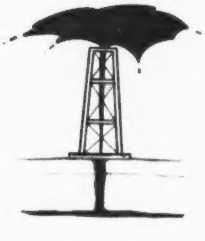


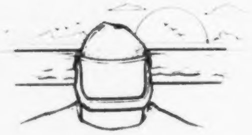


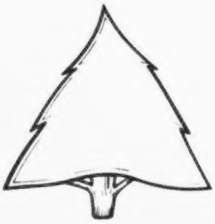


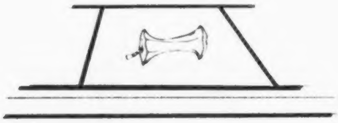




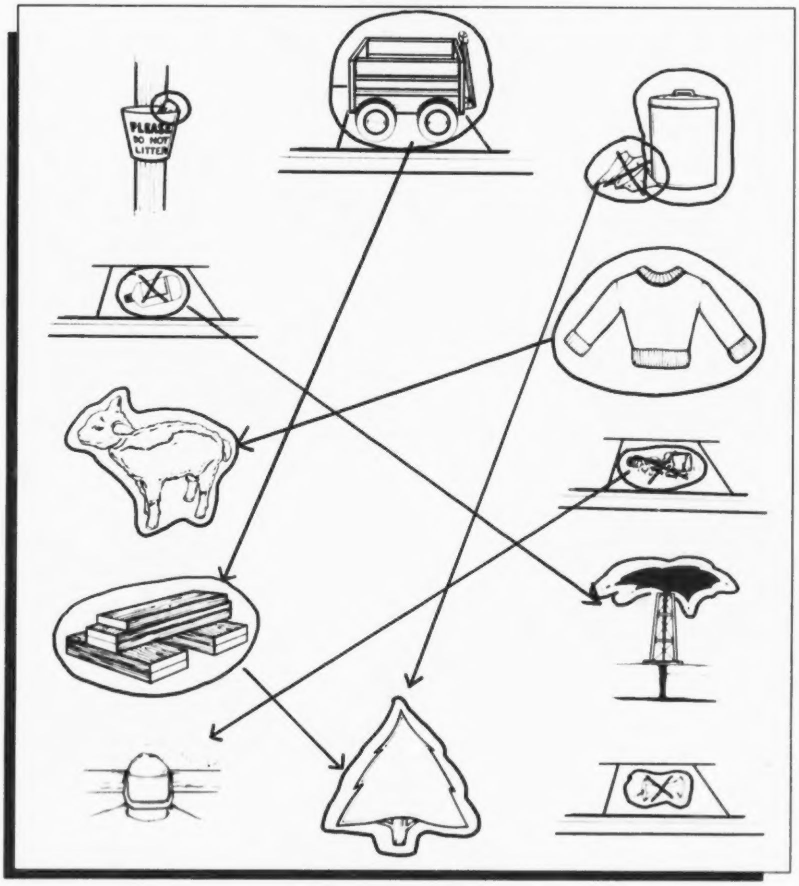








ANSWER KEY – NATURAL OR HUMAN-MADE?



wooden wagon:
human-made

can:
human-made;
container:
human-made

plastic
two-liter
bottle:
human-made

sheep: natural,
organic,
renewable

lumber:
human-made

sand: natural,
inorganic,
nonrenewable

trash can:
human-made;
paper: human-made

wool sweater:
human-made

glass bottle:
human-made

oil (petroleum):
natural,
organic,
nonrenewable

apple: natural,
organic,
renewable

tree: natural
organic, renewable

ADDITIONAL NOTES: Glass is made from sand (and other materials). Plastic is made from petroleum. Paper is made from trees. The can pictured in the container could have been made from aluminum or tinned-steel. If aluminum, the source is bauxite; if tin and steel, the sources are tin and iron-ore. Each of these sources is inorganic and nonrenewable. Glass, plastic, paper, and aluminum or steel represent the major recyclable items on this handout. Paper is the only one made from a renewable resource; however, there is so much sandstone in existence that we are not likely to run out of it nearly as soon as we could other nonrenewable resources. Clothing, often made from renewable resources, can be reused.

LITTER DICTIONARY COMPETITION CHAPTER 1

INTERMEDIATE

Objectives

Students will be able to: (1) *describe special properties* of litter and waste objects; (2) tell whether these items are recyclable or not. Students will improve their ability to *work cooperatively and productively with others.*

Method

Groups create an alphabet dictionary making illustrations and describing pieces of litter or waste that correspond with letters of the alphabet. They play a guessing and a rhyming game using information from pages of the dictionaries they made. They *infer* from descriptions of properties of waste items what the item is.

Duration: four or more class periods

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 1.1

Preparation

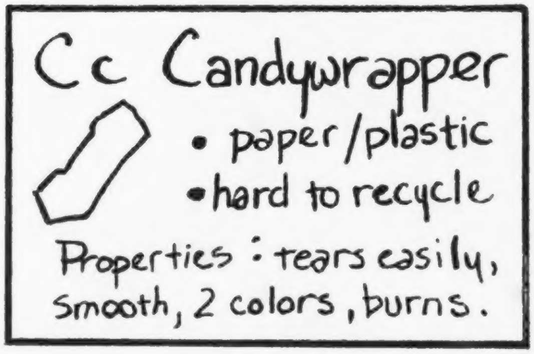
twenty-six sheets of drawing or construction paper and twenty-six sheets of draft paper available for each group of students; dictionaries, crayons, pencils and a variety of waste objects and/or pictures of potential throw-aways.

Vocabulary

alphabet, properties, recyclable, rhyme

Procedures

1. Collect a variety of litter and trash. Students might collect litter from an area around the school, bring in waste items from home and/or use magazines to find pictures of objects that usually end up being thrown away. Display these for everyone to see. Explain which materials are recyclable and which ones are not. (For a list of recyclable items see Background Information, Chapter 4.)
2. Divide students into teams or have them divide themselves into teams. Groups will identify objects of litter or waste according to letters of the alphabet. For each letter/object they will describe the following: a. material(s) used to make it (paper, glass, aluminum, etc.); b. whether it can be recycled or not; c. some of its properties (shiny, rough, bends easily, smooth, compacts easily, square, cylinder, etc.). Do an example for the class before having them begin.



Cc Candywrapper

- paper/plastic
- hard to recycle

Properties: tears easily, smooth, 2 colors, burns.

If students in the group cannot think of a waste item to match with a letter, they should go on to the next letter. Once they have identified a waste item for a letter of the alphabet have them complete as much information as possible, but they should go on to another letter if they cannot fill in all the requested information.

3. Have groups make a picture of each item and work out picture and word displays on draft paper before arranging on the final page. They should work together eliciting ideas from every-

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one in the group as to descriptions of each alphabetized item. Then have one or two students in the group copy onto the final page.

4. Tell each team to do as many letters of the alphabet as they can and not to discuss with other teams what they are doing. After allowing several class periods to complete, collect the finalized sheets from each team.

5. The winning team will be judged accordingly:

- 2 points for correctly identifying a piece of litter and spelling it correctly;
- 1 point for properly identifying material(s) used to make the item;
- 1 point for identifying correctly if it is recyclable or not, or difficult to recycle. This may be hardest to judge in some cases. Most waste can technically be recycled or composted, but efficient and remunerative systems are lacking for some waste materials such as certain plastics, batteries, aerosal cans, plastic coated papers, etc. (For an explanation of difficulties in recycling see Background Information, Chapter 4);
- 1 point for each property named.
(According to these criteria the example given above, in Step 2, would be worth 8 points.)

Tally points from all sheets of each group. Have a prize for the winners.

6. Sort out lettered sheets for which no waste item could be identified by any of the groups. Brainstorm as a class helping students think of items for these. Then have them return to groups to include letter/objects they could not think of the first time. Have each group put their sheets into booklet form binding all 26 pages and designing a cover, listing each student's name in the group. Or, you could make a single book from the best examples from each group. Display on classroom library table. Or, collect the sheets in loose but alphabetical order and use them to do the following exercise.

7. Choose the best pages from each group, especially those pages with correct "properties" descriptions. You may want to make photocopies of pages in order to preserve the book(s).

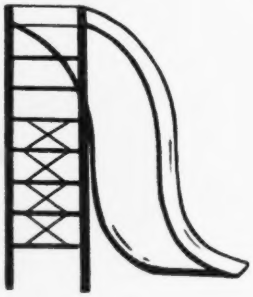
   a. Shuffle sheets of pages.

   b. Have a student read the "properties" description of the item on the page, and see who can guess what waste item is referred to in the description. Repeat, allowing other students to participate.

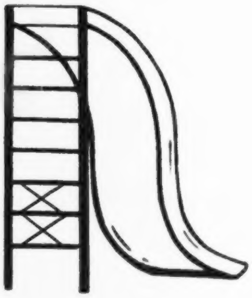
   c. With older students, after each item is guessed, discuss how the properties described make it easy or difficult to recycle or dispose of that particular item. (e.g. Newspaper is not very durable and it absorbs water easily, so it can be turned back into pulp for recycling; it will biodegrade in a landfill. An aluminum can has a relatively low melting point so it can be recycled easily. It can be compacted for storage until it gets to the recycler, and because it does not oxidize rapidly it will not biodegrade very quickly in a landfill. Plastic can be melted to be recycled. When plastic is incinerated, it gives off toxic gases which have to be captured before entering the atmosphere. Plastic is so durable it lasts almost forever in a landfill.)

8. Play a rhyming game using the list of waste objects the students described in their dictionaries.

   a. On the board, draw any number of slides depending on how many teams you divide the class into.



Team 1



Team 2

   b. Take turns giving one student from each team a word from the dictionaries the students made or any word related to litter. The student then has to find a word (not necessarily litter related) that rhymes with the given word. If the student has a rhyming word he/she goes up to the team slide and puts an "X" on the rung. The first team to the top wins. (NOTE: All slides must have the same number of rungs.)

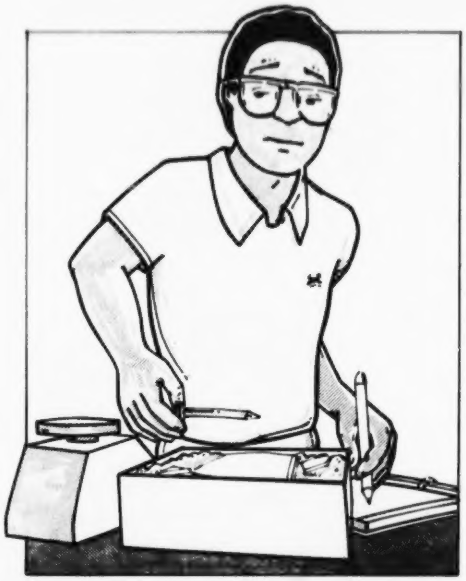
Examples:

From the Dictionary Pages		Rhyming Words
Cc	Can	Pan
Ww	Wrapper	Trapper
Ss	Shoe	Blue

Evaluation Have students describe their roles in the group and then have them list as many objects of litter and waste as they can, designating which types are recyclable (without using the booklets they just made).

DECOMPOSITION CONDITIONS

CHAPTER 1



INTERMEDIATE

Objectives Students will be able to: (1) *describe* the decomposition process; (2) *compare* rates of decomposition of various materials when left in the environment or disposed of in the ground; (3) *explain* why recycling saves landfill space. Students will improve *problem solving* skills and their ability to *work cooperatively in groups.*

Method Students discuss variables in the decomposition process and hypotheses related to changes in matter. They *conduct experiments* with waste items by creating mini-landfills. They use working hypotheses to *make inferences* and to present final conclusions about the decomposition rates of various waste items under test conditions.

Duration: several class periods over the course of a couple of months or more

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 1.2, 3.3

Special Note The making of a mini-landfill is one of the most popular activities in waste management activity guides. It can be done successfully in many different ways. The procedure described in this variation of a mini-landfill exercise requires the testing of several variables and the application of hands-on scientific observations guided by inferences and hypotheses. This calls for careful preparation by the teacher and an amount of time which teachers may not be able to give to a special interest subject during the year. Therefore, many short-cuts can be taken. Instead of cutting materials to specific sizes, just make sure a variety of waste items are used as you find them. The simplest way to conduct the experiment is to put all the items in a large glass jar or aquarium tank of dirt and have students observe changes through the glass over select periods of time during the school year.

Prior to doing this activity it is advised that at least one or two other activities in this chapter be done so students have a basic understanding of the properties of waste materials. Also, Background Information in Chapter 3 is helpful for understanding how organic materials used in this activity decompose.

Preparation Gather in a shoe box the ten items listed below. Allow one shoe box of items for each small group of students.

- piece of lettuce
- piece of bread
- light piece of cotton cloth 3″ × 3″ (piece of thin cotton handkerchief or other thin cotton material)
- a 3″ × 3″ piece of paper (newspaper or writing tablet paper)
- a 3″ × 3″ piece of cardboard
- a 3″ × 3″ piece of aluminum pie pan
- a long thin iron(not aluminum) nail (with no rust)
- a popsickle stick (or other piece of wood)
- a 3″ × 3″ cut-out of a plastic lid from a butter container, etc. or a 3″ × 3″ piece of plastic wrap
- a small glass jar (small jars for mushrooms, olives, mustard, etc.)

Collect the following items for the creation of mini-landfills:

- a container for each test sample group: buckets, dishwashing tubs, cut-off plastic gallon milk jugs, large peanut butter containers, large glass jars, etc. (It is not necessary to have the same type of container for each group.) To complete the experi-

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ment as suggested in the **Procedures**, at least three containers are called for. However, you can expand the experiment using four or more containers.

- soil or dirt from outdoors, enough to fill each group container near to the top. (Do not use potting soil, sandy soil or clay unless you want to create various soil conditions for comparisons.)
- rulers for each group
- a weight scale (one for entire class)
- tongs for picking up delicate or moldy items
- spray water bottle (one for entire class)

Vocabulary

biodegradable, change, decompose, evidence, experiment, experimental conditions, hypothesis, landfill, matter, nonbiodegradable, open dump, physical properties, simulation, variable

Handouts

Recording Changes; How Long to Biodegrade?

Procedures

IDEAS FOR THE EXPERIMENT

1. Examine the concept of "change" with students, explaining changes that result from wear or decay. Shoes and roads become worn and need repair, etc. Discuss how some things change slowly, some quickly. Do a demonstration with an ice cube and a flower: ice cube, at room temperature, changes (melts) quicker than the flower in water changes (withers or decays).
2. Divide the class into groups according to the number of test samples you have decided to use. Present the shoe boxes of items (described in the **Preparation**) to student groups. Show them the contents of one box identifying each material: glass, food, plastic, etc. Ask the class to think of a place where all these items might be found together (trash can, dump, landfill). Note that they are all found together if recycables are not separated from the trash. Ask students which materials could be recycled. Ask students what different types of waste the items in the box represent: organic/inorganic matter, made from renewable or from nonrenewable resources, etc. (Discussing these terms will be easier if you have had students do the activity, **NATURAL RESOURCES AND WASTE MATERIALS**, in this chapter.)
3. Explain to the class that most trash in the United States is disposed of in landfills. Ask them how they might make a test in the classroom to see what happens to these materials when they are taken to a landfill. This discussion should include the following considerations:
   - What is a landfill? It is a place where waste is buried in the ground. It differs basically from an open dump because each day trash is covered with a layer of soil (do not discuss why this is done, yet).
   - Weather conditions: rain and moisture are important factors at a landfill creating different effects on materials. (If there is too much moisture, not enough air will reach the waste matter, hence there will be less oxidation and fewer waste-eating bacteria which rely on oxygen to live.)
   - Different materials are buried in a landfill; some decay faster than others, while some do not appear to decompose at all.

   Explain the concept of variables to students and how moisture content, soil covering and properties of organic and inorganic materials represent variables in the decomposition process. Ask students how these variables in landfill conditions could be simulated in order to conduct an experiment about what happens to waste when it is put in the ground. Discuss the meaning of "simulation." After discussing the landfill simulation concept, show students the supplies for making a mini-landfill.

PREPARING THE EXPERIMENT

4. Ask students why scientists conduct experiments (to observe what happens under certain conditions). But what guides their observations and the specific conditions used in the experiment? For this, a major hypothesis and minor hypotheses are often used. Explain what a hypothesis is. Lead discussion around to establishing the following hypotheses.

   Major Hypothesis: All materials, living and non-living, are in a constant state of change, yet some materials change quicker than other materials. (This hypothesis was established in the first step of the activity. You could have written it down then and refer back to it now.)

Minor Hypotheses: These are related to the discussion in Step 3 and to knowledge about waste materials learned in prior activities of this chapter.

a. Most organic materials will change faster than inorganic materials in a landfill. (or) Inorganic materials will change faster than most organic materials. (Background Information in Chapter 3 discusses how organic matter decomposes and the variables involved.)

b. The more moisture or water in a landfill, the faster the materials will change. (or) The dryer the landfill is, the faster the materials will change.

c. Waste that is buried in the ground changes faster than waste not buried.

There are other hypotheses as well which you may want to consider testing in place of or in addition to those listed above. An extra hypothesis about soil permeability could be tested. It could be written as follows: Soil that is permeable (to water, such as sand and gravel) will cause materials to change faster than soil which is not permeable (clay). To test for this you will need to have different soil samples available. Another variable which could be tested is that of temperature. A refrigerator, or doing part of the activity outdoors during the winter, would be required to experiment with temperature.

The rest of this procedure description deals with the testing of "a," "b" and "c" above in Step 4. You may decide to test only one or two of these hypotheses to simplify the procedure. Just watching waste items change over a period of time in a jar of dirt will confirm the major hypothesis discussed above. (Remember — changes in glass or plastic will be imperceptible given the time available, but organic food waste and paper products should readily decay.)

CONDUCTING THE EXPERIMENT

5. Before proceeding to make the mini-landfill, give each group *two* copies of the handout, ***Recording Changes***, so that all ten waste items can be listed. Write the names of items (lettuce, bread, cloth, paper, cardboard, aluminum, iron, wood, plastic, glass) on the lines at the left. Have each group choose a person to record data on the chart. Students should examine all ten items carefully, describing various physical properties of each: size, shape, texture, color, weight. Have recorder describe these in column "INITIAL PROPERTIES OF OBJECTS."

6. Do this language arts extension. Have students write riddles that describe the waste items. Use at least three adjectives in each riddle. (Ex. "What is green, leafy and limp?")

7. Supervise the making of mini-landfills. Remember to construct each one in different ways, depending on which variable each group will test in their sample.

   a. To test for minor hypothesis "a" (in Step 4 above), make sure each item on the ***Recording Changes*** record sheet is identified as either "organic" (food items, paper, plastic, cloth, wood) or "inorganic" (iron, glass, aluminum). The word could be written below the name of the item. All groups can test for this, but under different conditions.

   b. Testing for minor hypothesis "b" (in Step 4 above) requires that mini-landfills be watered differently and/or one not at all. (As water may accumluate in the bottom of mini-landfills that are designated to receive water in various amounts, decaying processes may lead to a bad smell. To avoid this, add a small layer of crushed limestone in the bottom of these containers.)

   c. To test for minor hypothesis "c" (in Step 4 above), do not put a cover of dirt over materials in one of the containers of waste. Instead, put a window screen over it. You may want to make two "open dumps," testing one under rainy conditions and leaving the other dry all the time.

8. Proceed to have each group make a mini-landfill, putting dirt in the bottom of their container, then waste items, then more soil on top, if called for. Dampen soil with water, if called for, and in varying amounts in different containers, if called for.

9. Have each group decide what they think will happen to each item over a period of ten days. They should record their inferences in the col-

umn "WHAT YOU THINK WILL HAPPEN" on the ***Recording Changes*** handout. Tell them to rely on their knowledge of the landfill conditions and the properties of waste items to make these inferences. Have students describe how the physical properties of each item might change given the conditions of their test sample. Put mini-landfills in a safe place and store records and riddles in folders. Also, write out the conditions for each mini-landfill (whether to water and how much, how often; how much dirt cover it has, etc.), and keep these in the folder. Put special directions (such as "spray me with five squirts of water everyday") on each mini-landfill container.

10. At the end of ten days have groups assemble with their landfills. Open up a section of several pages of newspaper on each table as if reading it wide open. Have one student from each group carefully scoop out dirt with waste items. (To insure that the landfills which are watered a lot are not too messy, do not water two days prior to unearthing.) Carefully isolate all waste objects from the dirt using tongs for more delicate items. Record the properties of all objects just as done before, putting descriptions in the column "PROPERTIES AFTER ______ DAYS" (filling in how many days: "10" this time). Have each group compare inferences with what really happened and discuss with class.

11. Before restoring landfills, pass out new copies of record sheets, ***Recording Changes,*** to the students so they can record inferences again, only this time for what they think will happen to each item in twenty more days. (Do not fill out "INITIAL PROPERTIES" column this time.) If their inferences this time differ from last time, ask them why (observations under test conditions giving them more information).

12. Have students create riddles again and compare with ones they did last time. Put waste items carefully back in container. Holding newspaper at each end pour dirt on bottom, then put items back, then more dirt if called for. Follow initial test condition instructions. Store mini-landfills and records with riddles.

13. After twenty days have passed repeat procedure described in Step 10, only use the second set of record sheets with only "WHAT YOU THINK WILL HAPPEN" inferences recorded. Write a number 30 in the "DAYS" blank of the "PROPERTIES AFTER" column. Describe properties again and make new riddles. Store and do one more time if you wish, this time allowing as many days as you like to pass before examining contents again (preferably several months). Make sure to have students record descriptions in "PROPERTIES AFTER" column following their last unearthing.

EVALUATING THE EXPERIMENT

14. Have each group gather all their data and discuss in class the comparisons of the final descriptions (in "PROPERTIES AFTER" column of the last record sheets used) with the initial descriptions of the waste items (in "INITIAL PROPERTIES" column of first record sheets). Discuss the concept of biodegradation. Ask why some items decomposed faster than others. What was responsible for decomposing the vegetable scraps? Have each group create a conclusion for the rate of decomposition of each item. (Lettuce will decompose very quickly because it is an organic material that bacteria will attack. Glass bottles do not seem to decay at all because they are made of hard materials which bacteria cannot attack easily. Paper will eventually decay because it breaks up easily when exposed to environmental conditions of rain and soil pressure.)

15. Discuss the hypotheses and whether these were confirmed or disproved. Based on conclusions, decide what type of landfill environment is best for biodegrading waste. Also, compare the "open dump" simulation with the landfill simulations. (Waste may have biodegraded faster or at the same rate in the open dump, so ask class why we cover waste. It smells bad, looks bad, attracts pests which can spread disease.)

16. Discuss ways that landfill space can be saved: separate recyclables and take them to a recycling center; compact or shred waste before taking it to the landfill.

Evaluation

Give each group the handout, ***How Long to Biodegrade?*** Based on what they have learned from their experiments, have them complete this. Discuss answers.

MINI-LANDFILL OBJECTS

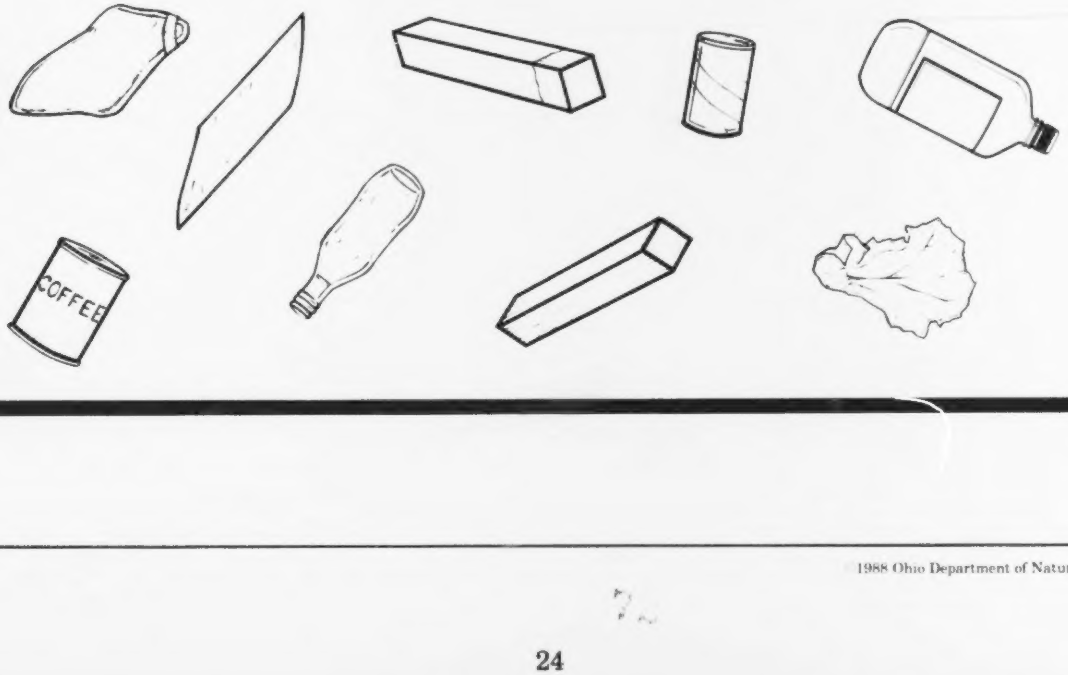
					INITIAL PROPERTIES OF OBJECTS
					WHAT YOU THINK WILL HAPPEN
					PROPERTIES AFTER ____ DAYS

HOW LONG TO BIODEGRADE?

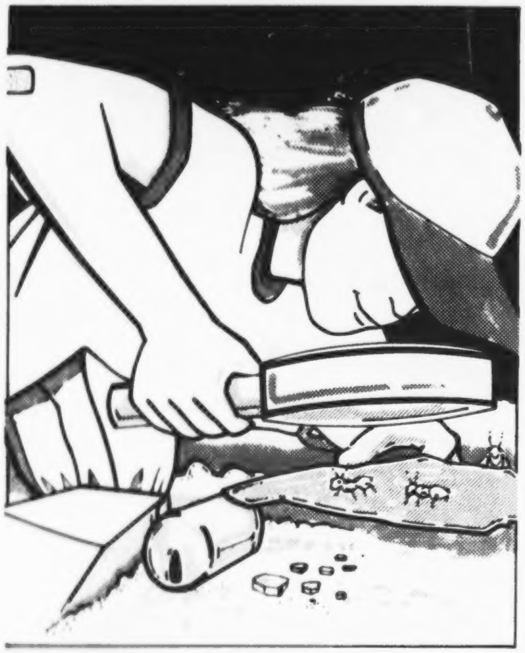
Directions: Rank the objects below, from the object which will decay the soonest to the object which will take the longest to decay. (The approximate time it takes for the items to biodegrade, when left in the environment, is listed to the right of each answer space.)

Objects: piece of paper, aluminum can, piece of lettuce, unpainted wooden fence post, plastic bottle, cotton rag, glass bottle, painted wooden fence post, tin can.

WASTE OBJECTS	ESTIMATED TIME TO DECAY
	(1-2 weeks)
	(2-4 weeks)
	(1-5 months)
	(1-4 years)
	(10-13 years)
	(100 years)
	(200-500 years)
	(500-1,000 years or more)
	(over 2,000 years)



THE ALIEN LITTER



INTERMEDIATE

Objectives Students will be able to: (1) distinguish natural waste from human-made waste; (2) *explain differences* in effect upon the environment of the two categories of waste. Students will improve their ability to *compare and contrast.*

Method Students *cooperate with others* to *record information* about the effects of waste materials on living organisms in outdoor areas. They share observations with others. They read passages in a handout to *identify the main idea of a paragraph.*

Duration: will vary over a period of two to four weeks

Setting: classroom, schoolyard

Subjects: Science, Language Arts

Curriculum Reference: 3.1

Preparation For each pair of students have the following: pencils, clipboard or portable surface to write on, hand lenses. Prepare a plot of ground, preferably a grassy area close to a woods. Rope off the space 10′ × 10′ or larger and put an abundance of different types of litter in the area (paper products, cellophane candy wrappers, cardboard pieces or box, pieces of metal and wood, glass bottles, aluminum cans, plastic bottles, organic food remains such as orange rinds and apple cores). Do this one week prior to initiating the activity in class, except for the organic items; distribute these two days prior. Try to weigh items down or wedge them so they won't blow away. You could also create several smaller plots in different places. To insure success of the activity your plot(s) need to have signs of life (plant or animal) around them. Depending on the environment one week may not be long enough to insure this. Because there is a follow-up observation in the activity, you could have students observe the plot once when there are few signs of life, and send students out again for the follow-up observation when you notice further signs of life. Before starting the activity, introduce the concept of habitat to students.

Vocabulary habitat, human-made, natural

Handouts ***Litter in Nature (in two pages); What's the Big Idea?***

Procedures

1. Discuss litter and differences between human-made litter and "natural litter." ("Natural litter," in the context of this activity, refers to natural objects littered by people.) The activity, **NATURAL RESOURCES AND WASTE MATERIALS**, in this chapter is helpful for understanding this distinction.
2. Pass out hand lenses and the handout sheets, ***Litter In Nature***. Have students work in pairs to complete the worksheets. Each group of partners can take turns during the course of the day (or week) going out and inspecting the plot. If there is a lot of space on the school property and many areas with litter, you might devise a way to take the whole class out at once, designating different littered places for the students to go, or you might arrange several smaller plots of litter ahead of time in various places in the school yard. Tell students to put everything back as they found it (you can initiate cleanup later, if you wish).

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3. Discuss the handouts after all groups have completed them. Explain the concept of habitat, and have students describe the habitat where they found animals living in the littered plot. Ask students if human-made objects or natural objects appear to be more of a threat to life in a habitat? Why? Discuss which items in the plot can be recycled and why they should be recycled.
4. Have students complete the handout, ***What's the Big Idea?***
5. Do the assignment again in another week or two, and have students record their observations on new copies of the handout. Have them compare handouts and describe changes over time.

Evaluation

Write the name of one human-made object and one natural object on the board (think of objects not part of the activity). Have each student explain in writing what effect each object might have on the environment. To do this they will make inferences based on observations and information recorded and discussed in the activity.

LITTER IN NATURE

Directions: Find some *human-made* litter. Using your hand lens, closely observe the area around it. Record your observations.

1. Describe the human-made litter you want to investigate (2 or 3 objects).

2. Investigate these objects. Look for and describe tiny animals or plants by the human-made litter. Are there any signs of animals having been around the litter: paw prints, gnawed edges, spider webs? Describe the signs. Will the litter harm the animals or plants in any way?

LITTER IN NATURE

Directions: Find some *natural litter* and make observations as you did on the first sheet.

3. Describe the natural litter you want to investigate (2 or 3 objects).

4. Look for and describe any tiny animals or plants by the natural litter. Are there signs of animals? Will the natural litter harm the plants or animals in any way?

"WHATS THE BIG IDEA?"

Directions: Read the following paragraphs. Then choose the sentence in each paragraph that is the main idea, and write it above the paragraph.

1. Litter consists of human-made materials and natural materials which are discarded improperly. Frequently after a picnic, people leave food scraps and paper products lying around. Sometimes when people finish drinking a can of pop, rather than carrying it with them to a trash container, they throw it down. Drivers who smoke often throw their cigarettes out of car windows. People also might let a material blow away or fall off a truck and not pick it up.

2. Fallen leaves can be a home for many insects and little animals. A rotten log provides a habitat for a variety of little critters, both inside and below the log. Fallen leaves, twigs and grass clippings which remain on the ground provide materials to become soil and to help soil hold moisture. Natural litter is made of leaves, twigs and other once living objects which accumulate naturally and are useful to nature in some way.

3. People should sort through their trash and recycle paper, bottles and cans. When we recycle these items, we are conserving resources such as trees, sand, iron ore and bauxite. Also, people could buy recycled or recyclable items and not purchase overpackaged products. All of us could think of ways to reuse some things we throw away. We need to encourage others to recycle. We have a lot of power to help conserve our natural resources.

Chapter 2

People and Waste

PEOPLE AND WASTE

CHAPTER 2

Waste at Home, School and Work

Waste material can be found anywhere people live, work and play. The most common types of waste we generate fall into four categories: *residential waste, commercial/institutional waste, industrial waste* and *agricultural waste.*

Residential waste includes a variety of items generated in the home. Food scraps and all sorts of containers and packaging, including metal, glass, plastic and paper items, are generated in the kitchen. In the garage or workshop, waste comes from automotive, decorating, building and gardening supplies. In the bathroom and hall closet, waste comes from cosmetics, medical products, laundry and house cleaning supplies. Many of these items contain hazardous substances and should be handled and disposed of carefully. Residential waste also includes grass clippings, leaves, and tree and shrub trimmings from homes as well as waste items that are collected from parks, sidewalks and roads in communities. Many of these waste materials are seasonal.

People at work and students at school produce different kinds of waste.[1] Commercial/institutional waste is generated in such places as offices, stores, schools, hospitals, laboratories, construction sites, loading/unloading operations, gas stations, and power plants. Some wastes generated at these places, such as hospital waste, may be contaminated with harmful substances or disease-causing agents. Institutional waste can be peculiar in nature, for example, the Federal Reserve Bank collects millions of worn-out, one-dollar bills every day as waste. Post offices contribute tons of junk and dead-letter mail to the waste system; libraries discard a lot of old books.

Industrial workplaces often generate large quantities of hazardous waste and reuseable wastes such as sawdust and steel trimmings. The food industry (including dairy, sugar, and canning plants) generates large volumes of solid waste. Some of these wastes pose difficult disposal problems and require inventive reuse and recycling applications. For instance, scrap sugar cane cannot be incinerated, so it is used to make building materials and paper. Remains from canning fruit are too wet to incinerate and take a long time to stabilize in landfills, so they are often composted or used in making particular products. Peach pits, for example, are used in making sandpaper.

Agricultural practices generate more wastes than residential, commercial and industrial sources combined (excepting mining wastes). These wastes include manure, prunings, harvesting residues, carcasses, greenhouse wastes, pesticide and herbicide residues and containers. Fortunately, many of these wastes are recycled or reused. For example, manure is used as fertilizer and wheat stalks are cut and baled for animal bedding.

The wastes from mining industries are usually considered in a separate category from other industries because mining efforts produce almost twice the amount of waste as all other sources combined. Most ores contain a very small amount of the product to be recovered (usually less than 10%), leaving 90% of the mined material to be discarded.

Different types of residential communities may generate waste reflective of special features of the community. Rural areas where farming exists, generate agricultural wastes and old farm equipment not found in urban communities. In urban areas, more industrial waste is generated than usually created in rural areas.

Litter and Littering

Waste materials, before they can be recycled or disposed of properly, must first of all be contained. Waste that is not contained properly is called litter. ***Litter*** is misplaced human-generated solid waste that results from direct action (throwing a can on the roadside) and indirect action (failing to secure trash can lids tightly).

Deliberate littering is an improper form of waste disposal similar to the illegal dumping of waste materials. In both cases, harm may be done to the environment in one or more ways including aesthetic degradation, injury to wildlife and threats to human health. Illegal dumping may be considered a behavioral extension of littering. Young children who learn the consequences of littering and how to avoid it may be inhibited from creating more damage when they are older and make choices of how to dispose of larger volumes of waste.

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[1] Much of the information which follows in this section has been taken from James Marshall, *Going to Waste: Where Will All The Garbage Go?* (Coward, McCann & Geoghegan, 1972).

The environmental impact of litter depends on the nature of littered items and on the characteristics of the land or water where they are deposited. Organic food matter may not be harmful when left in a natural environment in small amounts because it becomes a part of nature's own recycling system. Food waste on city streets, however, can be aesthetically degrading and a hazard to health. Human-made materials such as plastic, glass and aluminum when littered anywhere (in human or natural environments) always have an adverse environmental impact. These objects may become the home for disease-spreading insects such as flies and mosquitoes. They can cause external injury to animals or, if accidentally ingested, cause starvation or suffocation.

Litter comes from many sources. The Keep America Beautiful organization conducted research and identified seven sources for almost all litter. The seven sources are:

1. ***Household refuse putouts***: Improperly covered household trash cans are a source of litter as is waste contained in plastic or paper bags. Animals or people can knock over cans and open bags, and wind can blow trash from open cans.
2. ***Commercial refuse putouts***: Stores and businesses generate large amounts of waste. If garbage cans and dumpsters do not have tight-closing lids, or in some cases locks, animals, people and wind can cause littering.
3. ***Construction/demolition sites***: Scrap building materials can be blown or carried away from construction or demolition work areas and become litter if fences are not put around the site and containers with lids are not used.
4. ***Uncovered vehicles***: Materials can fall or blow from trucks or trailers creating serious hazards for other motorists, as well as litter. Loads should be tied down or covered with a tarp.
5. ***Loading docks***: The constant loading and unloading of vehicles can produce all kinds of debris. Storage bins and dumpsters should always be kept closed to prevent materials from being blown about or scattered by animals.
6. ***Motorists***: Materials of many kinds are often thrown from cars. Car litter bags and trash cans placed at parks, rest areas, gas stations and fast food stores help reduce this litter.
7. ***Pedestrians***: Waste is often dropped or thrown on the ground by people on foot. Containers along sidewalks and in recreation areas provide an opportunity to avoid littering.

It is estimated that 80% of all litter comes from the first five sources named above. Responsible solid waste management practices by home and business owners, waste haulers, industries and builders are necessary for litter prevention.

One problem with litter is that it is seldom confined at its source. Some litter moves by wind, water, animals and human traffic. Wind moves litter across smooth surfaces such as roadways and fields. Rain and running water carry litter from one location to another, until it is trapped. Exposed refuse can be picked up and carried off by dogs, cats and other animals. The movement of feet and cars transports litter. Urban litter eventually becomes trapped at such locations as:

- vacant fields
- fences and wall bases
- strips between roadways and sidewalks
- grassy areas
- embankments
- catch basins

Litter and the Law

Littering and improper waste disposal create eyesores, and health and safety hazards. Legal measures have been adopted to prevent improper containment and improper disposal practices. In Ohio, littering is a serious offense which is punishable by a fine of up to $500 and 60 days in jail. Law enforcement officers can issue tickets for casual littering from motor vehicles as they do for traffic violations such as speeding. In addition, the driver of a motor vehicle can be held responsible for litter discarded onto the roadway by passengers.

It is also illegal in Ohio to drive or move a vehicle on any highway with a load that is not secure. The law requires a covering on loads that can spill or drop litter on the roadway. Exceptions to this law include a farm vehicle used to transport agricultural products and a rubbish vehicle in the process of acquiring its load.

Illegal dumping is a serious aspect of littering. Dumping waste on private or public land or waterways is prohibited. Citizens should use licensed disposal facilities and insist that haulers who contract to dispose of trash use legal disposal methods.

Keeping America Beautiful

Keep America Beautiful, Inc. (KAB) was founded in 1953 as a national, nonprofit, public service organization. Its mission is to sustain a national movement to reduce and prevent littering through better solid waste management. The Clean Community System (CCS) of KAB uses a four-pronged approach to change wasteful behaviors: develop a unified, updated set of ordinances; use appropriate sanitation techniques; initiate ongoing public education; and conduct consistent enforcement of new ordinances. This approach applies techniques of behavioral science to encourage change in personal attitudes about handling solid waste. It focuses on people's attitudes and habits as the cause of litter.[2]

There are currently 470 certified Clean Community System cities and/or counties in the United States. Ohio has 34 KAB System communities.

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[2] To become involved in the program, a community must contact KAB for information and make an application for certification as a KAB community. This requires local leaders to gain support from key local officials.

IT ALL BEGINS AT HOME

CHAPTER **2**

PRIMARY

Objectives

Students will be able to: (1) *describe* types of waste generated by a household; (2) *make inferences* about quantities of household waste generated over a period of time; (3) *reason* why specific waste objects are found in different rooms of a house; (4) *explain* why different members of a family generate different types of waste. Students will improve observation and creative abilities.

Method

Students *manipulate materials* and *follow directions* to construct a booklet which depicts household waste objects in various rooms of a home. They bring a waste object from home and explain its source.

Duration: two to four periods over two days

Setting: classroom and home

Subjects: Social Studies, Arts and Crafts, Math

Curriculum Reference: 5.1

Preparation

construction paper, one-hole punch, yarn, scissors, glue, crayons

Vocabulary

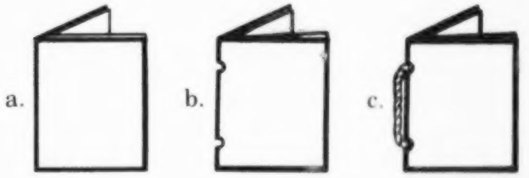
classify, garbage, hazardous, litter, trash

Handouts

Rooms People Live In; Waste at Home

Procedures

1. Help students make a booklet. The following is one suggested way: a. Give each student two sheets of construction paper and direct them to fold each piece in half and then insert one sheet into the other. b. With a single hole punch make a semicircle hole 2″ from top and another 2″ from the bottom into the creases in the folds (this will make a complete circle punched into the paper when booklet is opened). c. Use a piece of yarn to tie the two sections together.



2. Write the following list of rooms of a home on the board: living room, dining room, kitchen, bedroom, bathroom and basement.
3. Give each student the handout, ***Rooms People Live In***, and have them cut out the six pictures. Identify each room. If students are able, have them write the name of the rooms at the top of the inside pages of the booklet, one room on each page. Make sure they write the names of the rooms at the very top of the pages.
4. Leaving the front cover page of the book blank, direct students to glue one picture on each inside page (to match with the name of the room already written on the page, if done so).
5. Pass out the handout, ***Waste at Home.*** Have students cut out the twelve objects, and instruct them to glue the objects on the appropriate pages of rooms where they think the objects are likely to be found. Draw their attention to the size of each page and that it would be difficult to get more than two objects on a page, but emphasize to students that they are to use their own

© 1988 Ohio Department of Natural Resources; source: Dave Landis, DLPR.

judgment and that there are many possible answers. You may also want to instruct students to decide where they are going to place all twelve pictures before they glue them.

6. After pictures have been glued onto the pages of the booklet, have students make designs on front and back covers including pictures of their house or apartment, home garbage can, etc. They can put their name on front or back cover as well.
7. Have students present their booklets to the class telling why they put specific items where they did.
8. Discuss the distinction between garbage (grapefruit rind) and trash (non-putrescible items). Discuss which throw-away items in the booklet might be reused or saved and recycled. Discuss the hazardous nature of some household waste such as the paint can and aerosol insecticide can, noting that special disposal procedures are often called for. (If not all paint is used up, let it dry out in open air before throwing away. If it is oil base paint, keep away from flames. For spray cans of insecticide, use up any remaining contents. Never put in trash if any is left and never crush or compact an aerosol can. If the insecticide is very old, it may contain very hazardous chemicals now banned to consumers by the government. Check with local health department to see how it must be disposed.)
9. Ask students which of the items they have pasted in their books they have also seen as litter in their community. Discuss how these items became litter.
10. Ask students to infer what would happen if the collection people stopped picking up the trash from the curb or alley. Work out math problems based on how many cans or bottles, etc. are thrown away each week and multiply by four to see how much would be generated in a month, and by fifty-two to arrive at a total for the year.
11. Discuss which items in their booklets are recyclable. You could also have students make a floor plan of rooms in their home and identify all the materials in each room which can be recycled. Remember, in addition to objects made of glass, plastic, paper and aluminum, objects made of copper, brass, steel and cloth can also be recycled. Objects made of these materials could be door knobs, plumbing pipes, electric wall sockets, etc. In the garage items such as batteries, oil and radiators can be recycled.

Evaluation

Have students take their booklets home and use them as guides to list other items of trash that are discarded from the various rooms of their homes. Have them bring this list to class and discuss, including identification of recyclables. For students too young to write out a list at home, have them bring in one waste item (non-dangerous and clean) to share with the class. Discuss where it came from, what it was used for and in what room of the house it was found. Discuss what room in a house has the most trash and who in the house makes the most trash. When giving this assignment, make sure students ask their parents if they can do what is being requested.

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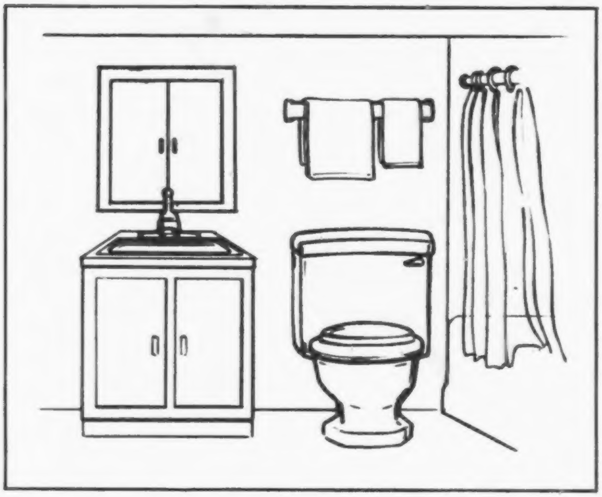
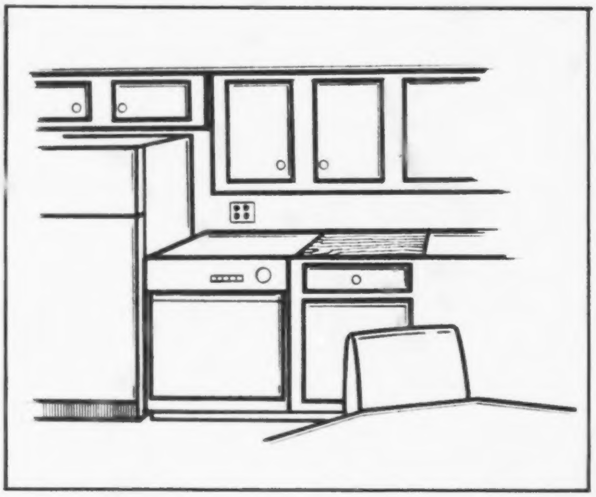
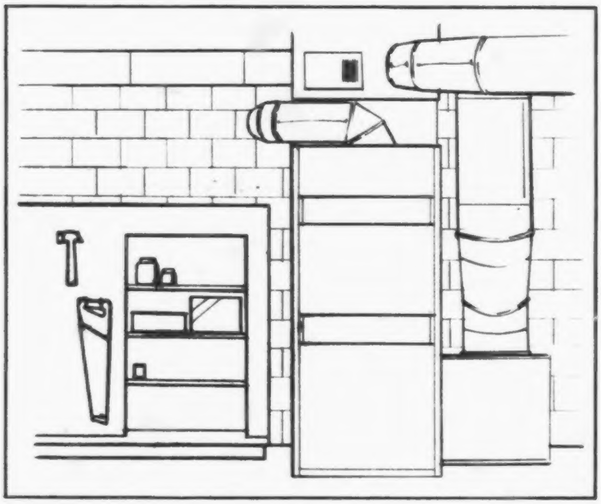
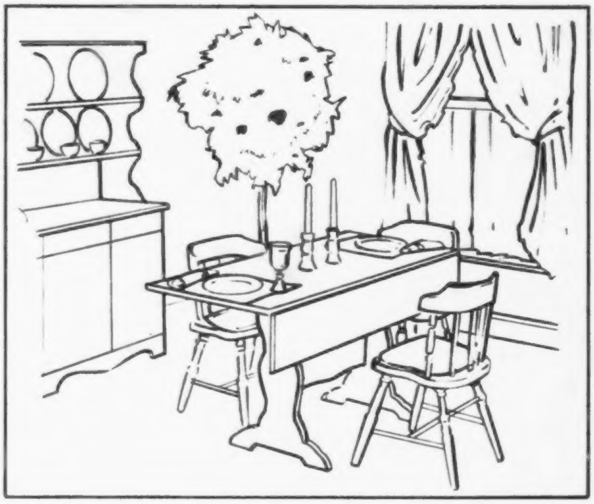
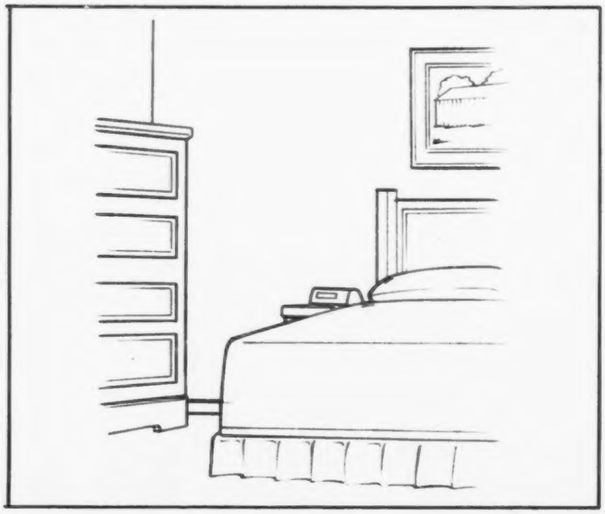
ROOMS PEOPLE LIVE IN

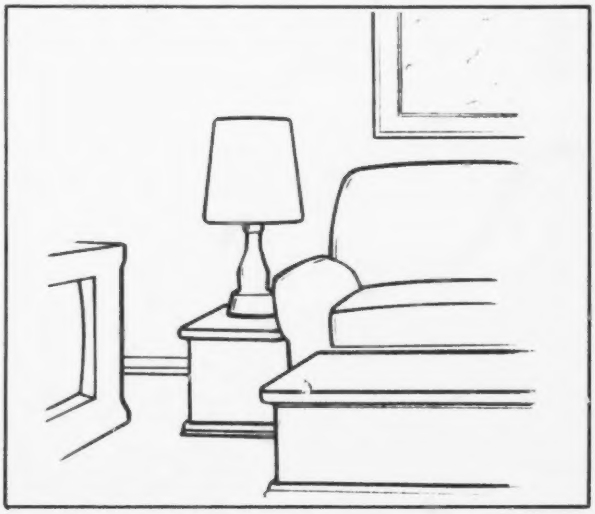


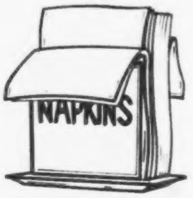












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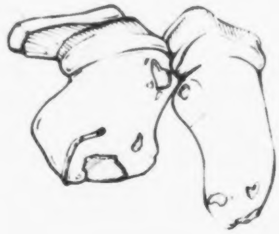

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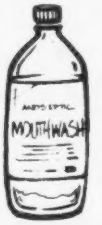
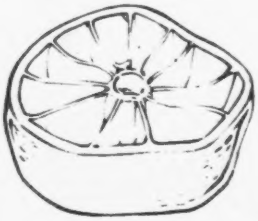
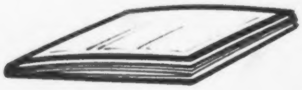


GLASS BOTTLE



GRAPEFRUIT RIND



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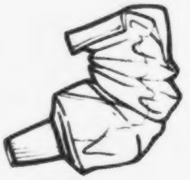
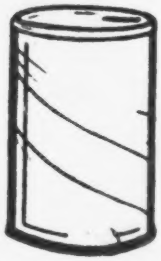
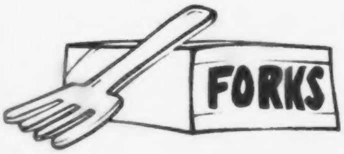


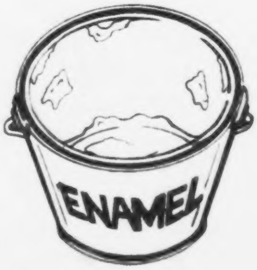
TOOTHPASTE TUBE



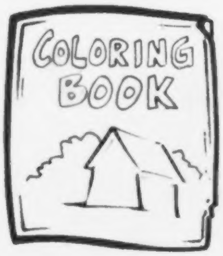
ALUMINUM CAN



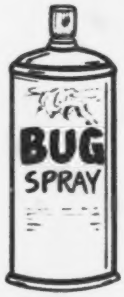
PLASTIC FORKS



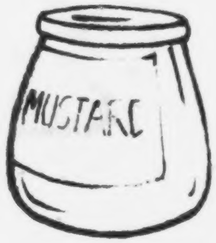
PAINT CAN


COLORING
BOOK

COLORING BOOK



AEROSOL CAN



GLASS JAR

WASTE IN THE WORKPLACE

CHAPTER 2

INTERMEDIATE

Objectives Students will be able to: (1) *reason* why different types of waste are generated in different work places; (2) *hypothesize* why certain types of trash are unique to particular occupations. Students will improve their ability to *organize data*.

Method Trash is collected from various occupations and brought into the classroom. Students *cooperate* in groups to *infer* from observations of the collected trash what the occupation of the person is who might have generated the trash. They complete a handout by identifying types of waste unique to particular occupations. Students identify recyclable items and suggest reuses.

Duration: two or three class periods after making preparations

Setting: classroom

Subjects: Social Studies, Math

Curriculum Reference: 5.1

Preparation Make arrangements to pick up trash from five or more occupations (within specific businesses) such as grocer, restaurant chef, secretary, salesman, housewife, farmer, auto mechanic, retail merchant, bank teller, etc. Request each person to put a few typical trash items they generate in a day (or perhaps in an hour or so) into a garbage bag you may want to provide. With each garbage bag given to a person, include smaller clear plastic bags for organic or smelly items if there are any. Also, ask each person to make a list of as many items of trash he or she can think of which are generated by the entire business in a typical day. Plan to use bags of trash in class soon after you collect them. Keep bags sealed and label with letters (A, B, C, D, E, etc.). A scale to weigh the trash bags is useful for this activity. Also, students will need writing materials. (NOTE: Throughout this activity you will need to define and explain different occupations.)

Vocabulary occupation, recyclable, unique, workplace

Handout ***Whose Trash is Whose?* (Part One and Part Two)**

Procedures

1. Define and describe the occupational areas represented by the bags of waste you have collected. Ask students to infer what the contents might be of each bag based on consideration of the occupation. Do not show contents of bag yet. Record inferences students have made. Weigh each trash bag and discuss whether trash can be matched to an occupation by weight.
2. Open bags of trash and leave displayed. Allow conversation time for students to match trash with occupations and to compare with their initial inferences.
3. Have students form groups, enough to have a group for each bag of trash. Have them choose one occupation/bag. Have each group discuss and answer the following questions, with one person from the group recording answers.
    a. List occupation of the person whose trash this is.
    b. What kind of workplace did the trash come from?
    c. Observe the trash and list as many different items as possible.

©1988 Ohio Department of Natural Resources; source: Kathleen E. Adams, Montgomery School (Ashland, OH).

d. List three articles (if possible) found in the trash bag which are unique to this occupation.

(The word "unique" used above refers to special waste items that are generated because of the particular nature of the job. This does not mean that these items could not be found in other occupations as well, only that they are fairly unique to the occupation in question. In some cases, however, the trash generated may be so unique as not to be found in other occupations.)

e. Go through the trash. List all recyclable articles and ways other items could be reused.

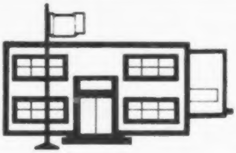
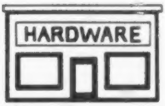
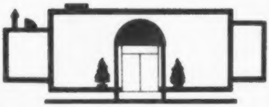
4. After an allotted time period, discuss the answers and summarize the results.
5. Ask students what other occupations might be part of the businesses or industries where the different bags were collected. Ask what types of trash these other occupations might generate. Compare their answers with lists obtained from your contacts who supplied you with the bags of trash.

Evaluation

Give each student the handout, ***Whose Trash is Whose?* (Part One)**, to complete. The answers at the bottom will help them to complete the worksheet. After they are finished with Part One, give them Part Two to complete. This time, in Part Two, draw their attention to possible answers at the bottom of the page but indicate that you would like to see answers not listed at the bottom, if they can think of other possible answers. This should apply to the occupational listing category as well as to the unique waste category. Note that no answers are given in Part Two for the similar trash column. Tell students to try and think of six different items to put down, in addition to the answers for this category given in Part One. After completion, discuss answers and ask which items could be recycled on their lists. The similar trash column should include many recyclables as this column represents consumer items used by all individuals in the workplace, often related to eating lunch or to supplies found in most places of business.

WHOSE TRASH IS WHOSE? (Part One)

Directions: For each workplace mentioned at the left of the chart
tion, name one item of trash which is fairly unique to that occup
one's trash can as well as in the trash can of the personal occupa
bottom.)

	SCHOOL TRASH FAIRLY UNIQUE
Teacher	old ch
Student	piece of
	BUSINESS
	TRADITIONAL RESTAURANT

POSSIBLE A

waiter/waitress, salesman/saleswoman, chef, secretary	product lists, chicken ribbon, menu list

, list two occupations in that workplace. Then, for each occupa-
ation and one item of trash which could be found in almost any-
tion you have just identified. (Possible answers are listed at the

TO THE OCCUPATION	TRASH THAT IS GENERALLY FOUND IN MANY OCCUPATIONS
alk	writing paper
rayon	milk carton

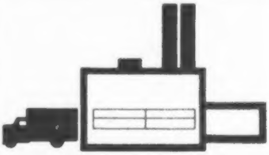
NSWERS

bones, typewriter	plastic package, paper, glass pop bottle, apple core

WHOSE TRASH IS WHOSE? (Part Two)

Directions: Complete, following instructions of Part 1.

TRASH FAIRLY UNIQU



FACTORY

FARM

FAST FOOD RESTAURANT

POSSIBLE

crop duster, counter cashier, machine operator, milking hand, warehouse worker, cook

cooking oil, weed
skids, styrofoam bo
oil can

E TO THE OCCUPATION	TRASH THAT IS GENERALLY FOUND IN MANY OCCUPATIONS

ANSWERS

killer can, wooden
ox, broken hay rake,

MAP OUT LITTER

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) identify specific places in their environment where litter exists; (2) *hypothesize* the most effective places for containers. Students will improve their ability to *analyze maps.*

Method

Students *follow oral directions* to place litter on a map. They cut out objects and draw pictures of environments with litter. They *analyze and explain* the most effective places to put containers. They *interpret symbols* on a map and locate placement of objects using letters and numbers.

Duration: three class periods and possibly extra time outside the classroom schedule

Setting: classroom, playground, community

Subject: Social Studies

Curriculum Reference: 5.1, 5.3

Preparation

Before initiating the activity read over the two options (for younger students; for older students) and decide if one or both are appropriate for your class. Supplies needed are: pencils, drawing paper and rulers.

Vocabulary

container, litter, map, symbols

Handouts

The Park; Litter In The Park; Litter Lanes

Procedures

FOR YOUNGER STUDENTS:

1. Give each student the handout, ***Litter In The Park***, and have them cut out the five items of litter; either have them cut along the dotted lines or have them cut out the object directly, depending on their abilities.
2. Give students the handout, ***The Park***, to lay beside the objects they just cut out. Tell students to pretend they are litterbugs. Have them follow these oral directions:
   a. Place the paper *below* the sandbox.
   b. Put the aluminum pop can at the *right* of the rocking horse.
   c. Place the glass bottle *in* the pond.
   d. Put the potato chip bag *above* the swing.
   e. Place the plastic milk jug at the *left* of the tree.

   Ask these questions. How does the playground look? What could be some reasons why children or adults might litter these items at a playground?
3. Tell the students to cut out the two trash cans from the handout, ***Litter In The Park***. Ask them to place the trash cans anywhere in the park where they think people will use them and glue the trash cans there. Ask students why they chose to put the containers where they did. Discuss and share their pictures.
4. Give each student a sheet of drawing paper. Take the children out to the playground at school and have them draw a map of their playground, placing the playground equipment in its correct place. Next they should walk around the playground and find where there is litter

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1988 Ohio Department of Natural Resources; source: Carla Dingledein Paulin, JC Sommer Elementary (Grove City, Oh) and Susan Harrison, DLPR

and place an "X" at all the areas on the map where they found litter.

5. In the classroom, discuss where students found litter. (Help students recognize that litter is found where people are or were at one time.) Ask children where they would place two trash cans on the playground; or, if there are already trash cans on the playground, ask them if there would be a better place for them. Conduct a cleanup of the playground.

FOR OLDER STUDENTS:

1. Give students the handout, ***Litter Lanes***. After completion, discuss answers with them.
2. Have class or school club "Adopt-A-Block" or neighborhood within a designated area of the community. Make a classroom map of this area and record the following:
   - where litter is found
   - how much was picked up by the class, either on a field trip or after school
   - where containers should be put where there are not any now
   - how long area stays clean after it has been cleaned up

   This exercise could also be done using the school playground as in the exercise for younger students.

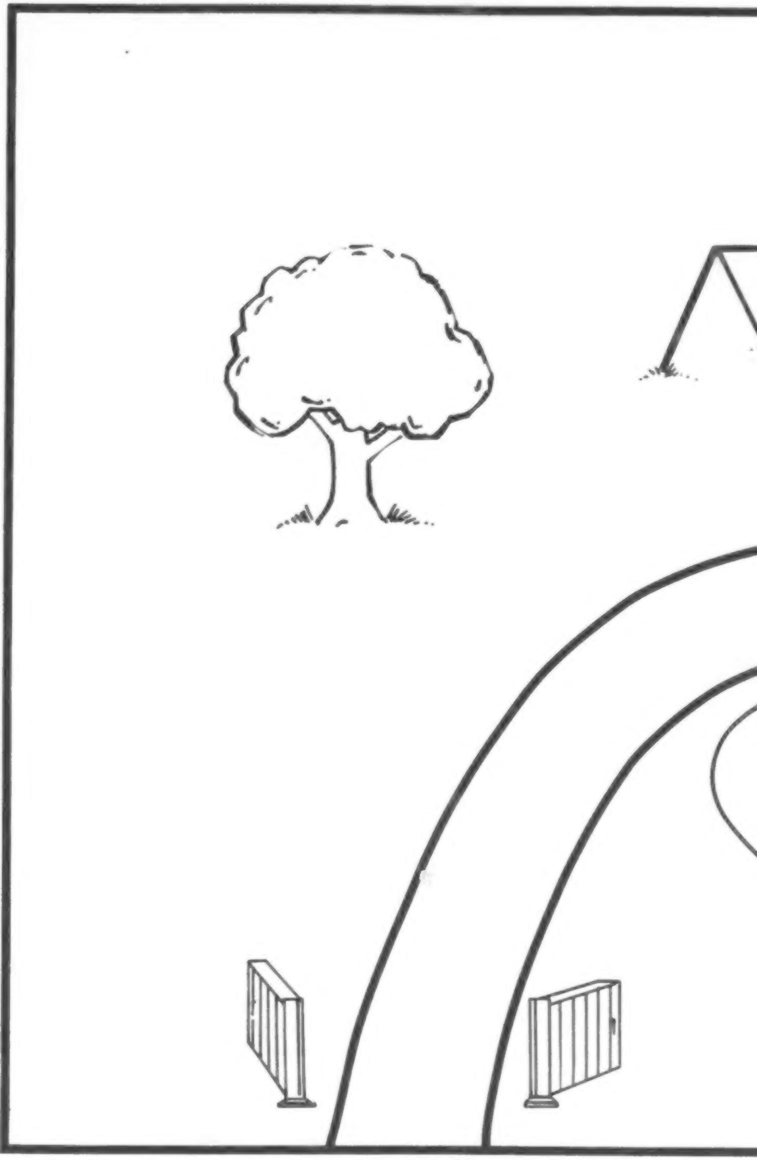
Evaluation

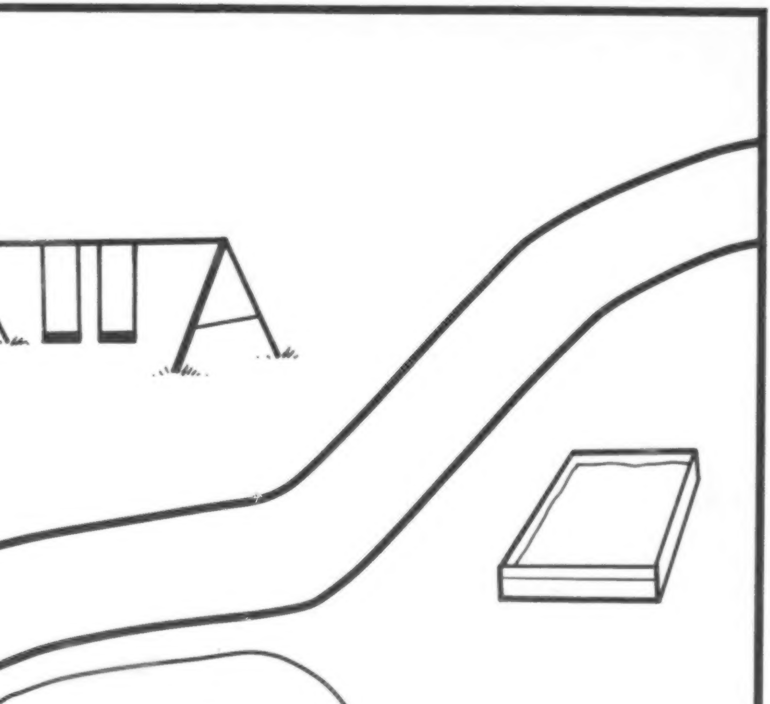
Give each student a sheet of drawing paper and ask them to find an area in their neighborhood (street, park, store, etc.) that contains litter, and draw a map of that place. Place an "X" at spots where litter was found. Have students bring their map to school and share it with the class. Ask the following questions:

1. Where is this place?
2. What is in your map?
3. Tell where you found litter.
4. Is there a trash can in the area? If not, where would you put one?

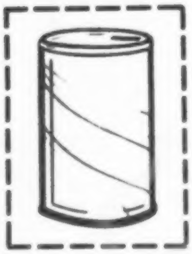
MAP OUT LITTER **2**

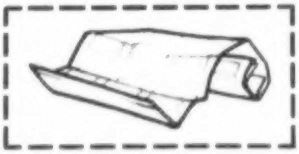
THE PARK

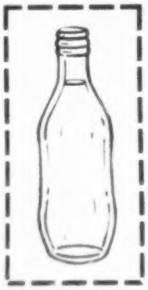


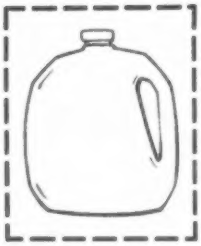


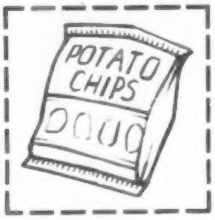
LITTER IN THE PARK

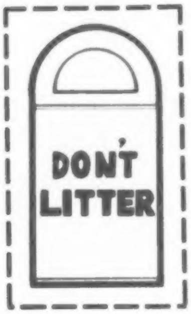


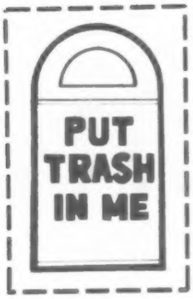




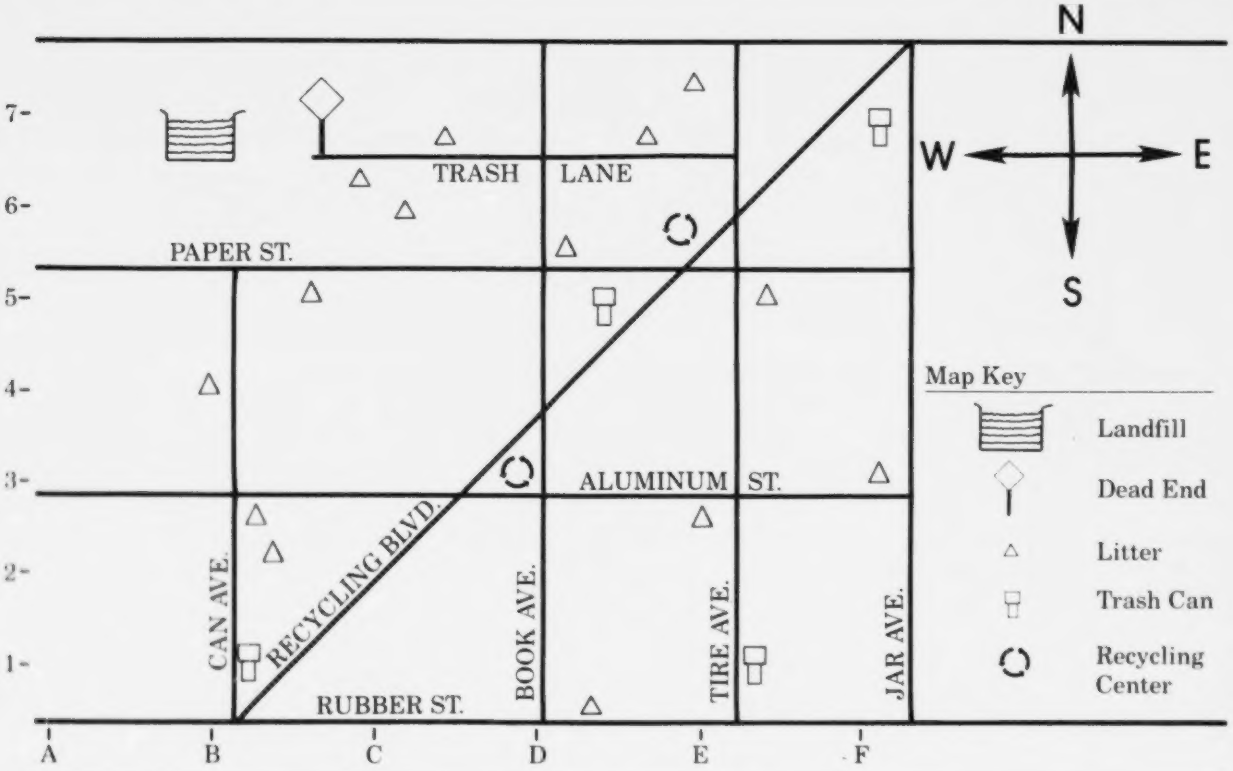



POTATO
CHIPS


DON'T
LITTER


PUT
TRASH
IN ME

LITTER LANES


N
W
E
S
7-
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1-
TRASH
LANE
PAPER ST.
ALUMINUM
ST.
RECYCLING BLVD.
CAN AVE.
BOOK AVE.
TIRE AVE.
JAR AVE.
RUBBER ST.
A
B
C
D
E
F
Map Key
Landfill
Dead End
Litter
Trash Can
Recycling Center

1. Name the only dead end road on the map. ______________________
2. How many recycling centers are there? ______
3. Draw the map symbol for litter. ______
4. What is at the end of Trash Lane? ________________
5. Name the road that runs NE-SW. ______________________
6. Match the *Material Street* with its *Product Avenue.* Draw arrows from streets to avenues they match.

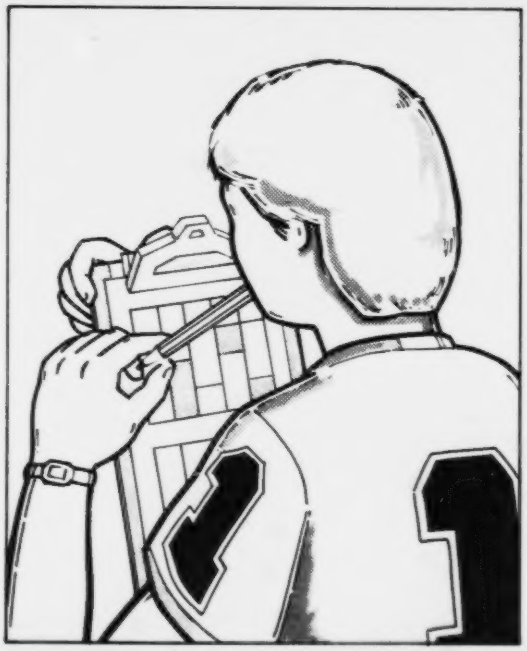
Glass St.	Book Ave.
Rubber St.	Can Ave.
Paper St.	Jar Ave.
Aluminum St.	Tire Ave.

7. Name the only litter free road. ________________
8. Why is it litter free? ____
9. What is located at coordinate 7-F? ________________
10. Identify by number and letter where the two recycling centers are located.

_______ – _______　　　_______ – _______

LITTER BY COMMUNITY

CHAPTER 2



INTERMEDIATE

Objectives

Students will be able to: (1) *explain* why different types and amounts of litter exist in different places within communities. Students will improve their abilities to *make deductions* from information and to *organize data*.

Method

Students read descriptions of three types of communities and *make inferences* about different types and amounts of litter and waste in each community by filling in a chart. Students *cooperate in groups* to reassess individual inferences. Students *create a hypothesis* and explain how it could be tested.

Duration: three class periods

Setting: classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 5.1

Preparation

large sheets of butcher paper, pencils, crayons, markers

Vocabulary

community, hypothesis, litter, rural, suburban, urban, waste

Handout

Quantities and Communities

Procedures

1. Distribute handout, ***Quantities and Communities***, to each student.
2. Have each student infer the different amounts and kinds of litter found in each community by filling in the chart. Teacher may need to explain and define key words on the chart.
3. Have students divide themselves into groups so they can share their answers and reasoning. Have a student distribute to each group another copy of ***Quantities and Communities*** so that groups can fill out the chart again, this time based on group discussion.
4. Discuss group answers, identifying plausible answers based on reasoning from information given at top of handout. Discuss with students how they changed their answers based on group discussion and hence the value of sharing information with others.
5. Looking at the chart, distinguish various places in each of the three communities where the most litter is likely to be found. What types of litter would be found there? Why?
6. Ask students where most landfills are found (suburban or rural areas). Why? Ask which littered items on the chart could be reused or recycled to save landfill space.
7. Discuss other types of waste and litter that could have been put on the chart. Brainstorm items somewhat unique to rural, urban or suburban communities (e.g. large dead animals in rural areas).

Evaluation

1. Write the open sentence below on the board and have students fill in the blanks. Tell students the sentence is really a hypothesis; explain what a hypothesis is.

More ______________________ is/are littered in
(a)
______________________________ areas than in
(b)
__________________________________ areas.
(c)

© 1988 Ohio Department of Natural Resources; source: Marilee King, Olivehill Elementary (Trotwood, OH)

   a. Choose one item from chart.
   b. Choose community type from chart or a specific place within a particular community.
   c. Choose another community type from chart or another specific place within a particular community.

2. Ask students how they could test their hypothesis statement. They could also write a paragraph using the hypothesis statement as the main idea.

3 TYPES OF C

URBAN: many people, many businesses and some fa
with small yards; not many trees; not a lo

SUBURBAN: not as many people, some businesses
homes have larger yards, more bush
spaces and fields

RURAL: few people, some businesses, some factories
lot of open, empty spaces by roadsides

Directions: Fill in the chart with the number indicat
found in each community.

KEY: “1” = some, “2” =

	PAPER	CARDBOARD	GLASS BOTTLES	PLASTIC BOTTLES	ALUMINUM CANS
URBAN					
SUBURBAN					
RURAL					

COMMUNITIES

ctories — light and heavy industry; apartments, homes
of open, empty spaces, some vacant lots

(in malls especially), some factories — light industry;
es and trees, some small gardens; some empty open

— light industry; farms where cattle and crops grow; a

ing how much of each type of *litter* you think would be

more than some, "3" = lots

APPLIANCES (stoves & refrigerators)	FURNITURE	TIRES	BRANCHES GRASS LEAVES	PESTICIDE CONTAINERS

AT THE SOURCE

CHAPTER 2

LET'S CLEAN UP THIS COMMUNITY
A.
B.
C.
D.
E.
F.
G.

PRIMARY/INTERMEDIATE

Objectives Students will be able to: (1) identify seven sources of litter in their community; (2) *reason* how littering takes place at the seven identifiable sources. Students will improve their abilities to *observe* carefully and to *solve problems.*

Method Students discuss littering behaviors after identifying their feelings about litter. They *describe* sources of litter by observing illustrations on a handout, and *explain* why littering happens at these sources. They identify litter according to sources of litter in their own community. They initiate a cleanup, if feasible, and recommend solutions to litter problems.

Duration: two class periods with extensions for recorded observations at home and/or a cleanup in the community

Setting: classroom, home and/or community

Subjects: Social Studies, Language Arts

Curriculum Reference: 5.1

Preparation Before initiating the activity read over the two options (for younger students, for older students) and decide if one or both are appropriate for your class. After completing the classroom assignment you may decide to initiate a cleanup. To do this, you will need to make the following preparations. Write letters to the parents explaining a cleanup project, requesting their help and informing them of the date. Make necessary arrangements for a school "field trip" if the community area to be cleaned is not the school playground. You may need letters to parents, field trip permission slips, garbage bags or home-made litter bags, gloves for students if called for, parent helpers, and transportation.

Vocabulary commercial, construction site, demolition site, feelings, household, litter, loading dock, motorist, pedestrian, refuse, source, vehicle.

Handouts ***Seven Sources of Litter; Where and How?***

Procedures

FOR YOUNGER STUDENTS:

1. Introduce the subject of litter. (Litter is an object. Littering is a behavior associated with the improper disposal of an object.) Explain what a "source" of something is.
2. Give students the handout, ***Seven Sources of Litter***, on which they are to identify their feelings. Draw three types of faces on the board for them to choose from (happy, sad, uncertain). Tell them to draw a face in the circle beside each picture that shows how they feel about what is happening. (Note that picture "C" should be the only happy face.)
3. Discuss their answers and while doing so have students describe the source of litter in each picture.
   A. Household refuse putout (home garbage containers or bags left for pickup)
   B. Loading dock (includes storage bins or large dumpsters)
   D. Commercial refuse putout (may include large dumpsters)

©1988 Ohio Department of Natural Resources; source: Regina James, Hadden School (Painesville, Oh) and David Landis, DLPR.

E. Motorist

F. Construction/Demolition site (often a large area, sometimes with fence around to contain materials)

G. Uncovered vehicle (usually trucks)

H. Pedestrian

(These seven "most frequent" sources have been identified by: Keep America Beautiful Inc., in their Clean Community System Research.)

4. Ask how the litter got to be where it is in each picture. (Note: Wind and animals often carry litter from open or even closed containers, but most often human irresponsibility is at fault.)

FOR OLDER STUDENTS:

1. Substitute source identification for making faces. Draw the attention of students to the list of sources (write these on the board) and have them write the name of the source that matches with each picture in the block below each picture.
2. In the circles beside each picture (where younger students draw faces) have older students rate each source of litter (excluding "C") from most offensive (#1) to least offensive (#7). Discuss answers asking students to give reasons for their choices.
3. As a follow-up ask students to save this handout and to make a record of litter and littering habits in their community for the next week by describing each observation of littering according to one of the seven sources. They may also identify sources not among the seven "most frequent" sources listed on the handout.
4. If possible, have students take photographs of places where litter exists, then identify them in class according to the source depicted.

Initiate a Cleanup

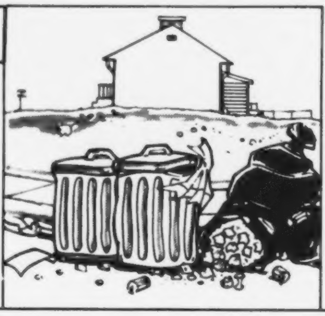
Before the students begin a community cleanup project (either on the playground or at another area), the teacher should explain any rules that are necessary, such as, "Parent helpers should pick up broken glass and trash which is in the water." Students could work in small groups with a parent helper supervising litter collection. After the litter is collected and placed in bags, it should be taken back to the classroom, so students can sort out items which can be saved for recycling. Note: During the cleanup you could have students record the sources of litter they find, and after the cleanup have them suggest ways to keep waste from being littered in the areas they cleaned up.

Evaluation

For younger students, display a variety of littered items (cans, paper, bottles, candy wrappers, etc.). Have each student choose one item and explain to the class how many ways the object might have become litter, based on its source. For older students, test their knowledge of the seven sources of litter. Give them the handout, ***Where and How***, to complete. Grade answers.

SEVEN SOURCES OF LITTER

A



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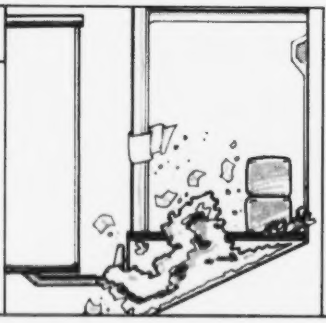
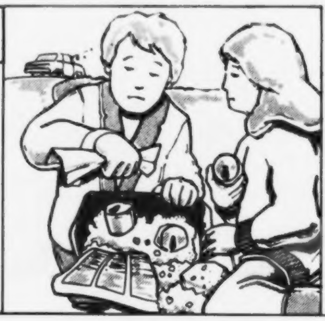


C



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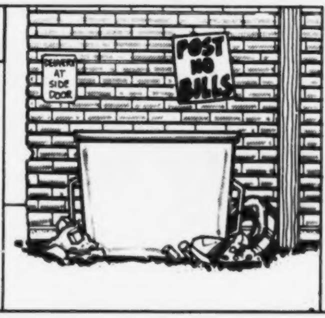
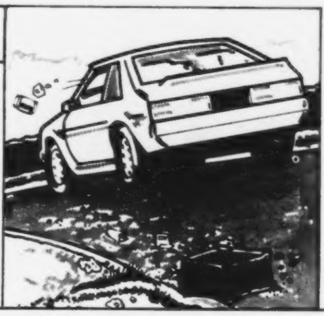

DELIVERY AT SIDE DOOR
POST NO BILLS

E



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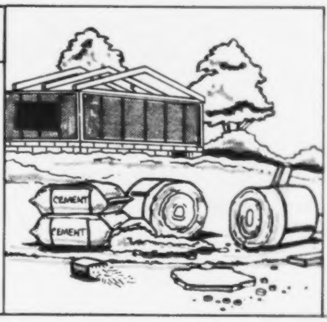
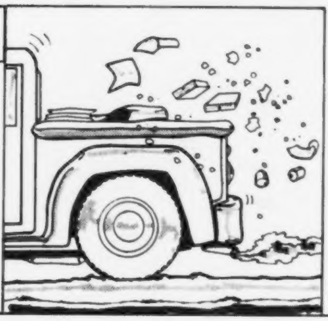
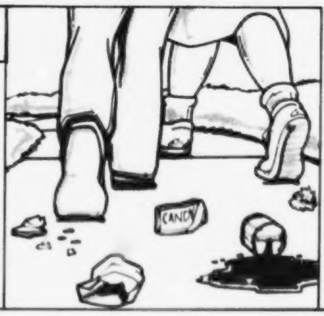

CEMENT
CEMENT

G



H



WHERE AND HOW?

Directions: Answer the first two questions and then read directions for answering the next seven questions.

A. Define LITTER on the back of this page or on a separate sheet of paper.
B. Define SOURCE on the back of this page or on a separate sheet of paper.

There are seven sources of litter listed at the bottom of the page. Write one of these seven sources in the blank space to complete each sentence below.

1. When products are delivered to or picked up from stores, businesses or factories, litter is often created around a ____________________.
2. ____________________ litter is created by careless people who throw trash out of a car window.
3. Building materials such as wood, nails, insulation, roof shingles and metal strips are often found as litter close to a ____________________.
4. When lids are not tight, the wind can blow trash, which becomes litter, from ______________________________ put out in front of houses.
5. Objects can fall out of a truck or blow off a truck if it is an ____________________.
6. ____________________ litter is caused by people who drop trash as they walk along a road or sidewalk.
7. When businesses fail to dispose of their trash so that it escapes from containers or is not properly put in containers, this source of litter is called a ____________________ source.

motorist
pedestrian
construction site
commercial
household containers
loading dock
uncovered vehicle

TIME TO CELEBRATE! BUT WAIT!

INTERMEDIATE

Objectives

Students will be able to *describe* litter problems created by special events and to *propose solutions* to these problems. Students will improve their ability to *write descriptively*.

Method

Students discuss pictures of special events and possible litter problems associated with them. They read an article and answer questions by identifying descriptive words and phrases in the article. They write their own newspaper article. They *make inferences* about possible litter problems by observing pictures of special events.

Duration: two to four class periods

Setting: classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 5.1

Preparation

newspapers and magazines with articles of celebrations and events; if possible, pictures of crowds or after crowds have left and pictures of cleanup crews at work after a special event

Vocabulary

litter, special events

Handout

Litter News

Procedures

1. By use of pictures from magazines or newspapers stimulate students to discuss litter which is often left behind after large celebrations and special events.
2. Have students read and complete the handout, ***Litter News***.
3. Instruct students to write their own news article either about an imaginary special event with an ensuing litter problem, or if possible, about an event they remember having been to themselves. Make sure they tell who, what and where in the article; use descriptive words; create a headline; propose ways (through use of quotes from the mayor or person in charge of the cleanup) that the litter problem might be avoided in the future at this event.
4. Tell students to collect articles about litter problems and bring them into class for a month. Post on bulletin board and discuss.

Evaluation

Have each student find a picture of a special event in a newspaper or magazine and infer what types of litter might be generated by the event and the cleanup problems created; or, answer each question below in two or three sentences.

1. What are some problems caused by litter left after an event?
2. How can *we* help reduce the amount of litter at special events?

©1988 Ohio Department of Natural Resources; source: Celeste F. Geise, Ottoville Local School (Ottoville, OH).

PARTY LEAVES TRASH COLLECTORS WITH HANGOVER

CINCINNATI (UPI) August 26, 1986 — It was quite a party — and quite a hangover for trash collectors.

Mountains of trash littered the Ohio River shoreline Monday in the wake of Cincinnati's annual fireworks display Sunday night that attracted 300,000 people.

"There's a lot of debris all over the downtown area," said Pete Edelmayer, assistant supervisor of the city's street cleaning crew.

I've had four mechanical sweepers in the downtown area since 4 a.m. and I'm putting hand crews on to clean up the sidewalks," he added.

Police officials were pleased with the relative lack of problems from the throng of 300,000 that jammed the riverfront area to watch the city's annual late-summer fireworks display.

Although there were the usual traffic jams and minor accidents, there were no major incidents.

Directions: Answer the following questions referring to the article above.

1. What terms are used to describe the litter problem?

   a. ____________________ b. ____________________

   c. ____________________

2. What words tell us where the litter was?

   a. ____________________ b. ____________________

   c. ____________________

3. What caused the litter? (What event?) ____________________

4. How many people caused the litter? ____________________

5. The litter was cleaned from the area by

   a. ____________________ b. ____________________

6. On the back of this sheet, suggest ways to prevent this litter problem in the future at this event.

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Chapter 3

Nature's Way With Waste

NATURE'S WAY WITH WASTE

CHAPTER 3

Nature's Recycling System

An often forgotten fact of nature is that the survival of all plants and animals depends on tiny microorganisms which feed upon the wastes of living things and upon organisms when they die. These microorganisms are called ***decomposers*** and are part of every food chain. They include different types of microscopic bacteria and various ***fungi*** such as molds, mushrooms and mildews.[1] Decomposers are found everywhere but are most plentiful in soil. A single tablespoon of good top soil may contain up to four billion bacteria. ***Bacteria*** are essential to life because they renew nutrients to the soil as they break down waste. Soil rich in nutrients from the breakdown of organic materials by bacteria and fungi is called ***humus***. The matter left behind by bacteria also gives soil a texture necessary to retain proper amounts of water.

Decomposers are not the only organisms at work breaking down waste and dead matter. In fact, often before decomposers can do their work, waste matter must be broken down by larger organisms called ***scavengers***. Scavengers include insects (beetles, ants, termites), water creatures (snails, fish), birds (vultures, crows, sea gulls) and mammals (raccoons, rats, bears). Large scavengers (vultures, hyenas, rats) work on bulk waste such as carcasses. Small scavengers (insects, centipedes, slugs, snails, earthworms) work on bulk waste and smaller bits of decaying plant and animal matter, breaking them down into tiny pieces for the decomposers to work on.

Scavengers also prepare food for decomposers in another way. They consume living or dead matter and metabolize it leaving behind excrement or ***dung*** on which bacteria feed. As the bacteria feed on waste, instead of excreting dung, they leave behind chemical compounds which are nutrients that green plants can absorb. Together, scavengers and decomposers act as nature's sanitation crew and as recyclers.

Composting as a Form of Recycling and Waste Management

The breakdown of waste matter is very important because it enables the creation of humus in top soil. Human beings can assist nature's recycling process for renewing texture and nutrients to the soil by creating humus in the form of compost. ***Compost*** is made by combining food waste, yard waste, manure or fertilizer and other types of biodegradable garbage, and exposing them to air and water. Under these conditions, bacteria break down the waste matter efficiently. The resulting compost can then be added to soil to enrich it and improve its texture.[2]

There are two forms of composting, distinguished by two types of bacteria which break down waste: aerobic and anaerobic bacteria. Anaerobic composting (or anaerobic digestion) relies on anaerobic bacteria to decompose organic wastes. ***Anaerobic bacteria*** thrive on little or no oxygen and are used in treating sewage sludges and in making a semi-solid slurry for composting. Anaerobic composting gives off pungent odors and so is unpopular. Its advantages are that it does not require space for aeration as does aerobic composting and it produces more nitrogen than aerobic composting.[3]

The type of composting explored here is aerobic composting which relies on ***aerobic bacteria***. ***Aerobic composting*** requires oxygen and does not have the unpleasant odors associated with anaerobic composting. However, if aerobic compost piles are not properly aerated or ventilated, or receive too much moisture, anaerobic bacteria will appear, causing a foul smell and creating acids. A similar process happens in sanitary landfills. Since garbage at a sanitary landfill is compacted and covered with earth each day, aerobic bacteria soon die, while anaerobic bacteria begin multiplying, leading to the production of acids and carbon dioxide.

Aerobic composting, which is what is meant whenever the word *composting* is used in the rest of this chapter, is the only biological method of solid waste treatment that is widely used. It is usually done on a small scale in backyards or farmers' gardens. However, large-scale applications of the composting process are gaining popularity among waste management experts, because it is estimated that as much as 30-40% of the waste stream contains compostables.[4] Composting could therefore reduce landfill volume at the same time it produces an end product of value to gardeners, farmers and landscapers.

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[1] Bacteria are single celled organisms; fungi are nongreen plants which are incapable of photosynthesis, thus they, like bacteria, must feed on organic matter. Bacteria can be helpful and harmful. Their helpful function as nature's recyclers will be explored in this chapter, however, some bacteria cause diseases in plants and animals. Pneumonia is caused by a bacterium. Fungi, also like bacteria, can be helpful and harmful. Some types of fungus are used to make antibiotics such as penicillin, yet another type causes athlete's foot.

[2] Composting is a biological system of recycling in contrast to physical or chemical systems found in the recycling of human-made products such as glass, plastic and aluminum. Other biological methods of waste recycling include the spreading of wastewater sludges on the land and the production of ethanol from cellulosic wastes.

[3] Clarence G. Golueke, ***Biological Reclamation of Solid Wastes*** (Rodale, 1977), p.5

For large-scale composting endeavors, compostable materials can either be separated from other trash at a source point (household, restaurant) or separated at refuse collection centers. Then the materials ferment and decompose at facilities that use special processes and techniques. One popular technique is to make compost in large open spaces where machines moisten and aerate rows of compost. Odors and dust which may result can be controlled by deodorizing with air misters, by spraying chemicals like hydrogen peroxide on the compost and by increasing aeration.

The Requirements of Composting

Composting is the work of decomposers (bacteria and fungi), often aided by tiny scavengers such as insects, mites and especially earthworms.[5] To explain how composting works is really to explain how decomposer plants and animals meet their needs and multiply depending upon different environmental conditions. The needs of aerobic bacteria, fungi and small organisms at work in a compost pile are as follows:

OXYGEN — needed by most plants and animals to live. Oxygen is increased in compost by turning the pile occasionally or by aerating it.

MOISTURE — needed by bacteria to carry on metabolism or the breaking down of matter. Compost piles should be watered so they are like a wrung-out sponge.

ENERGY SOURCE — needed by all living organisms to survive and carry on life processes. In compost, energy is provided in the form of garbage which contains carbon compounds such as simple sugars, cellulose and lignin.

NUTRIENTS — represented by a variety of minerals and vitamins needed in varying amounts by different organisms. Vitamins can be found in most plant and animal tissue while manure or fertilizers are rich in nitrogen and other elements needed by plants.[6]

When these needs are supplied by their environment, bacteria begin to multiply, giving off heat as a product of bacterial metabolism.

Heat then becoms an important variable for the existence of different types of bacteria. When a compost pile is first formed, it starts out cool which enhances the reproduction of bacteria known as PSYCHROPHILES. They multiply in temperatures from 30°to 50°F. As the temperature increases to 70° up to 100°F another type of bacteria start to multiply, the MESOPHILES. As the temperature reaches anywhere from 100° to 160°F, bacteria called THERMOPHILES begin to reproduce. Thermophilic bacteria, at a temperature of about 140°F, begin to kill disease-causing microbes (pathogens) by producing organic compounds known as antibiotics. The temperature of a compost pile will generally stabilize at about 158° for three to five days and then drop down to a range where mesophiles take over again.

Bacteria are not the only organisms at work in a compost pile. Fungi clean up after bacteria consuming what they leave behind, including tougher matter such as the remaining cellulose, starches and lignin. It is fungi that usually break down paper, a human-made product more durable than most food garbage. Another decomposer often found in compost is the actinomycete, a type of bacterium resembling grey cobwebs, which gives the compost an earthy smell.

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[4] *Biocycle*. "Accelerated Co-Composting of Refuse and Sludge." March, 1985, pp. 42-43.

[5] Earthworms are important (sometimes people even add a hybrid variety to their compost) because they pass organic matter and bacteria through their bodies leaving behind granules rich in plant nutrients.

[6] Stu Campbell, *Let It Rot!* (Pownal, Vermont: Garden Way Publishing, 1975.) Much of the general information about composting in the rest of this chapter has been taken from this source and is reprinted by permission of the publisher.

Making Compost

To insure a variety of nutrients and a good consistency to compost, a general rule is to add as many different organic items to your pile as possible. A few precautions should be taken, as some items can create undesirable conditions. These variables and others will be discussed in sections which follow. In this section the basics of building a compost pile will be examined.

Compost is most often built up outdoors in a pile and often some type of support structure for the pile is used, but extra support is not necessary. Composting can also be done in garbage cans kept in a garage or basement, or in a large tub or aquarium kept in the classroom for observation. Regardless of where and in what you construct your compost pile, the general rule of thumb for building the compost heap is as follows:

1. Mix the variety of vegetable matter you have collected as thoroughly as possible, chopping it into little pieces.

2. Obtain manure (or fertilizer) and animal remains if you have them. Chop animal remains into little pieces. (Avoid using animal fat or grease.)

3. At the bottom of your compost heap create a structure to allow water to drain and to allow a bit of air in. If building outdoors, this could be accomplished with a layer of gravel and/or brush that has not been chopped up. If using a garbage can, drill holes in the bottom, layer the bottom with coarse material and set the can on blocks with drain pans beneath. If using an aquarium, place a layer of finely crushed limestone (which neutralizes acid) with coarse material in the bottom.

4. Begin with a layer of vegetable matter, followed by a second layer of different vegetable matter if you wish. Then put on a layer of animal matter (manure is best, or fertilizer). Then cover with a thin layer of soil. You may want to put on a sprinkling of lime or put limestone on the soil to neutralize acids which may develop.

5. Dampen these layers with water and repeat the process of layering as designated in Step 4 above. You can build as many of these layered sections as you wish. (If building outside, a good rule is to keep any one layer of material to 6″ or less; if building indoors in small containers, layers of 1″ or 2″ will suffice.)

6. If building outdoors, make the pile somewhere between 4-6 feet in height. If making in a garbage can or aquarium, fill to the top.

7. If making a pile outdoors, cover the entire pile with a layer of soil or straw or sod to keep flies out.

8. Make sure to ventilate the pile. If compost is outdoors or in a garbage can, a section of perforated pipe could be inserted into the center. If using an aquarium, put a small piece of wood or cloth under the cover at the corners to lift the top up. If you have a wooden top of plywood you could drill holes in it. You could also poke holes into the pile and stick straw or a cornstalk into the holes. After initially sitting for a week or so, start turning the pile about every week to allow air to get in.

When is compost ready?

There are several indicators to look for to tell if compost is ready and if it is of good quality. Generally, the process takes about 4-6 months; if temperatures are higher, as in summer, it may take less time. In winter months outdoors, it could take longer. The observations and measurements used to check on finished compost are listed below:

CONSISTENCY: should be crumbly and fluffy, not sticky or stringy

COLOR: dark in color, but not black which could indicate too much moisture and acid in the compost

SMELL: sweet and earthy, not moldy or rotten

TEMPERATURE: should be that of surrounding temperature having come down from higher levels of about 150° or so

It is always better to use compost which is not quite finished rather than over-done compost which is dried out.

Apply compost at anytime in any amount. Just spread it on top of the soil or work into the soil. Generally, compost is added to soil in the fall or in the spring one month before planting.

Remember, compost does not contain everything a plant needs. It could be lacking in some essential nutrients such as phosphorous, so you may want to add a commercial fertilizer to the soil along with your compost.

Variables and Experimenting

Many variables can be considered in the creation of compost. The basic variables are moisture, air and heat. Another important variable is the type of organic material put in the compost. Additional variables include acidity level and the carbon/nitrogen balance. Each of these factors will be considered individually below.

MOISTURE allows organic matter to be broken down more easily by bacteria. Water the pile and/or add green matter instead of drier materials if the pile is too dry. Too much moisture, however, can lead to a restriction of air and cause anaerobic bacteria to multiply. Moisture content of the material in the pile should be about 40-60% (like a wrung-out sponge). Use rain water because it picks up a lot of oxygen, minerals and microorganisms or tap water which has been set out for several days so that chemicals harmful to bacteria can evaporate.

OXYGEN allows aerobic bacteria to survive; too much air may cool the pile down, but not enough oxygen inhibits decay. Turning the pile will generally allow it to heat up. Why? Because oxygen allows bacteria to work and they in turn generate heat. To keep the pile at maximum heat capacity, turn it whenever the temperature gets below 104°F. If a bluish-grey mold appears (indicating anaerobic conditions) turn the pile right away.

HEAT is important because it destroys pathogenic organisms, weed seeds and insect larvae. For at least a short period of time the temperature of the pile should be around 150°. This may be difficult to achieve if your pile is not at least a cubic yard in size so it will self-insulate.

THE FORM OF ORGANIC MATTER often causes different things to happen in your pile. Make sure to chop and grind waste matter to make it decay faster, especially in the case of items such as broccoli stems, corn stalks, wet leaves and sticks. Chopping helps break down cell walls made of cellulose, which are difficult for bacteria to work on. Be careful not to make a fine mixture or you may create a paste-like barrier against water and air. If you blend kitchen garbage into a slurry, spread it out over the pile evenly. One rule of thumb regarding materials is to include two parts vegetable matter to one part animal matter. AVOID grease, oil and animal fat. These are hard to break down and will attract flies and vermin. A few suggestions of the many different items you could use are as follows:

Animal Matter — dead fish or fish cleanings, dead birds, manure, bones, scraps, feathers, leather dust, wool rags. (These items will add nitrogen and/or phosphorous to your compost.) Manure is especially important and can be used instead of any other animal matter to supply nitrogen.

Vegetable Matter — beet tops, broccoli and cabbage stalks, potato skins, citrus rinds, coffee grounds, egg shells, tea leaves, corn cobs and stalks, grass and hedge clippings, leaves, pine needles, sawdust, tomato plants and stems, peanut hulls, weathered hay or straw (if not weathered, straw will require a lot of nitrogen to decay). Partially rotted leaves (leaf mold) are the closest thing to pure humus. But mix and chop leaves if they are not weathered.

Mineral Matter — rocks (granite and marble dust), ground limestone and shells (crushed oyster, clam and lobster shells).

Matter Changed Chemically — wood ashes (source of potash and calcium). Ashes from burning banana skins, lemon skins and cucumbers are high in phosphorous and potassium.

DO NOT ADD root crops suffering from dry rot, onions with onion mildew, or other questionable vegetable or animal matter. Often the "thermal kill" of the composting process will not kill all pathogenic organisms and hence disease could be spread to plants when the compost is put on soil. Coal ashes have excessive amounts of sulfur and iron, which are toxic to plants. Charcoal takes a long time to decay.

NUTRIENTS are needed by plants. Some of these are as follows:

Major Nutrients — phosphorous, nitrogen and potassium or potash (nitrogen is perhaps the most important)

Minor Nutrients — calcium, magnesium, iron
Trace Elements — zinc and copper

ACIDITY (pH level): Plants will be poisoned if the pH level of the compost is too high or too low. There are various tests to show pH levels. A test which shows degrees of acidity based on colors is a popular one in school labs. If the pH is too acidic (too low), wood ashes, bone meal, lime or crushed limestone will neutralize acid. If the pH is too alkaline (too high) manure will generally lower the pH. Note that oak leaves, pine needles and pine sawdust are highly acidic and could be added to lower pH or not added at all to avoid a low pH. In the early stages the compost pile tends to be more acidic than it should be later.

CARBON/NITROGEN BALANCE: Humus is usually ten parts carbon and one part nitrogen. Compost should be around 25 to 1. Too much carbon (from items such as straw, corncobs, sawdust and pine needles) causes the pile to decay very slowly. This can be corrected by adding nitrogen in the form of manure. But you can also get too much nitrogen, which gives off ammonia causing anaerobic bacteria to appear. So if your pile smells of ammonia, let more air into the pile.

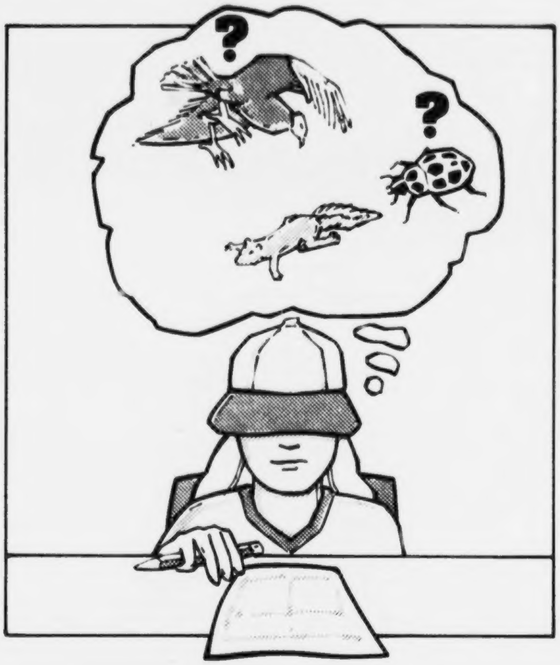
There are tests to show the carbon/nitrogen balance in your pile and to show the nutrient content. These can be expensive and difficult to use but may be worth trying if you have the time and money.

The Value of Compost

Composting recycles nutrients. However, the value of compost extends beyond its contribution of nutrients to the soil. Unlike chemical fertilizers, it contributes to good soil structure. Good structure allows soil to retain nutrients, moisture and oxygen over a long period of time. Therefore, compost extends the life of soil. Soil is one of our most valuable resources which is constantly being eroded away in places all over the world.

NATURAL RECYCLING

CHAPTER **3**



PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *describe* the role of scavengers and decomposers in nature's recycling and sanitation process; (2) *compare* nature's recycling process with the recycling of human-made products. Students will improve their ability to *make analogies*.

Method

Students compare nature and natural objects with human manufacturing and human-made objects by "webbing" forest elements and by "webbing" factory elements. They identify pictures of scavengers and decomposers. Students *listen* to a story about the roles and relationships of scavengers and decomposers and use this information to answer questions about picture sequences of natural recycling processes. They identify illustrations of natural recycling and of human recycling processes. They role play or *write* a comparison describing analogies between nature's recycling process and the human recycling process.

Duration: five to six class periods (if completion of all handouts is decided upon)

Setting: classroom (and outdoor follow-up exercise)

Subjects: Science, Language Arts

Curriculum Reference: 1.2, 1.7, 3.3

Preparation

writing materials

Vocabulary

analogy, animal matter, bacteria, cellulose, decomposer, dung, fungi, human-made, nutrients, organic, recycling process, sanitation, scavenger, sequence, soil, synthetic, vegetable matter

Handouts

Forest Web; Factory Web; Nature's Sanitation Crew; Nature's Recycling Process; Describing Nature's Recycling Process; Two Recycling Systems; and a reading story, ***The Great Breakdown***

Procedures

1. Have students close their eyes and think of a forest for a few minutes. Distribute the handout, ***Forest Web***, and have students "web" the word forest. To do this they write down as many things they can think of which create a web-like effect in a forest (squirrels, leaves, sun, etc.). Then, have students think of a factory with their eyes closed. Give them the handout, ***Factory Web***, to write down as many things as they can think of which are associated with factories (large buildings, machines, products such as automobiles, bottles, plastic toys, refrigerators, etc.). Make a clear distinction between organic materials that are a part of a *natural* forest web and *human-made* materials that make up most items in a factory web. Tell students to put aside the factory web for now and consider the forest web only.
2. Ask what happens to all the leaves that fall on the forest floor every year. Why don't they pile up year after year? To help students answer this question, have them look at their forest webs to

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see if anyone mentioned soil. Discuss why soil is important. It contains nutrients which plants need to grow and without plants, animals, including humans, would not be able to live. But how do nutrients get in the soil? Living in soil are tiny single celled organisms called bacteria. They eat decaying waste material such as leaves, dung and garbage leaving the nutrients from this matter in the soil. Bacteria serve two purposes: they help clean up the forest, and they restore texture and nutrients to the soil. But bacteria are not the only organisms at work breaking down waste; there are other decomposers and scavengers at work.

3. To help describe decomposers and scavengers in nature's recycling process, give each student the handout, ***Nature's Sanitation Crew***, to complete. You may want to read the passage with students and explain the meaning of "sanitation crew" in the title.

4. To help explain the role of decomposers and scavengers in nature's recycling process and to describe the interrelationships between decomposers and scavengers, do the following exercise:

    a. Read the story, ***The Great Breakdown***, to students. Or, make a copy for each student and have them read along with you.

    b. To test their comprehension of concepts discussed in the story give each student the handout, ***Nature's Recycling Process***, to complete. Note that the answers for this handout are to be taken from the handout, ***Nature's Sanitation Crew***, previously completed. Use the letters of each picture found in ***Nature's Sanitation Crew*** as answers. NOTE: THERE ARE MANY POSSIBLE ANSWERS AND MORE THAN ONE ANSWER FOR SOME SQUARES. JUDGE ANSWERS BASED ON EACH STUDENT'S REASONING BEHIND ANSWERS.

5. After discussing all the possible answers students came up with, have each one answer the questions on the handout, ***Describing Nature's Recycling Process***.

6. Return to the ***Forest Web*** handout students completed. Discuss how various items they mentioned are recycled by nature. (Everything should be recyclable except the sun.) Now look at the handout, ***Factory Web*** and discuss how various items they mentioned on this handout can be recycled. Discuss the concept of human recycling and what some of the requirements are, e.g. technology to break down human-made materials (analogous to decomposers in nature) and people to collect recyclables (analogous to some scavengers in nature).

7. See if students can make analogies with human-made recycling processes by answering questions on the handout, ***Two Recycling Systems***. You may want to have students first describe what is happening in each picture cycle.

8. Engage younger students in a role playing activity. Assign six children to form a tree. They can hold hands and form a circle (becoming the trunk of the tree). Have three children lay on the floor as roots. Have four more children be the leaves of the tree and "attach" themselves somewhere on the trunk. They can drift down and fall to the ground where the munchers and crunchers (three of each) can pretend to *eat* them and break them down. The leaves should curl up as they get broken down into smaller and smaller pieces. These decomposed leaves crawl back up through the tree trunk by way of the roots. They then become new leaves. Now assign the same six children who formed the tree to form a glass bottle by holding hands in a circle. Ask students who or what is going to break the bottle into pieces so it can be recycled. (a crushing machine) Have four students that were leaves before act like machines causing the six to unlock hands and sit down. What is going to break these down like the munchers and the crunchers of leaves? (A hot oven will melt the glass.) Have students that were "munchers" and "crunchers" before be a big oven ("melters") by holding hands around the six students representing pieces of glass. What will happen to the melted glass? (It will be made into new glass by machines that will blow air into gobs of the hot melted glass.) Have the "melters" blow on the pieces of glass until they stand with hands joined again.

Evaluation

1. Write the statements below on the board. Have students copy and put them in order from 1 - 5 to show how a tree's leaves are recycled.

   _______ Leaves are eaten by scavengers.
   _______ Nutrients are returned to the soil.
   _______ Leaves fall to the ground.
   _______ The tree reuses the nutrients to grow.
   _______ Tiny pieces of leaves are eaten by decomposers.

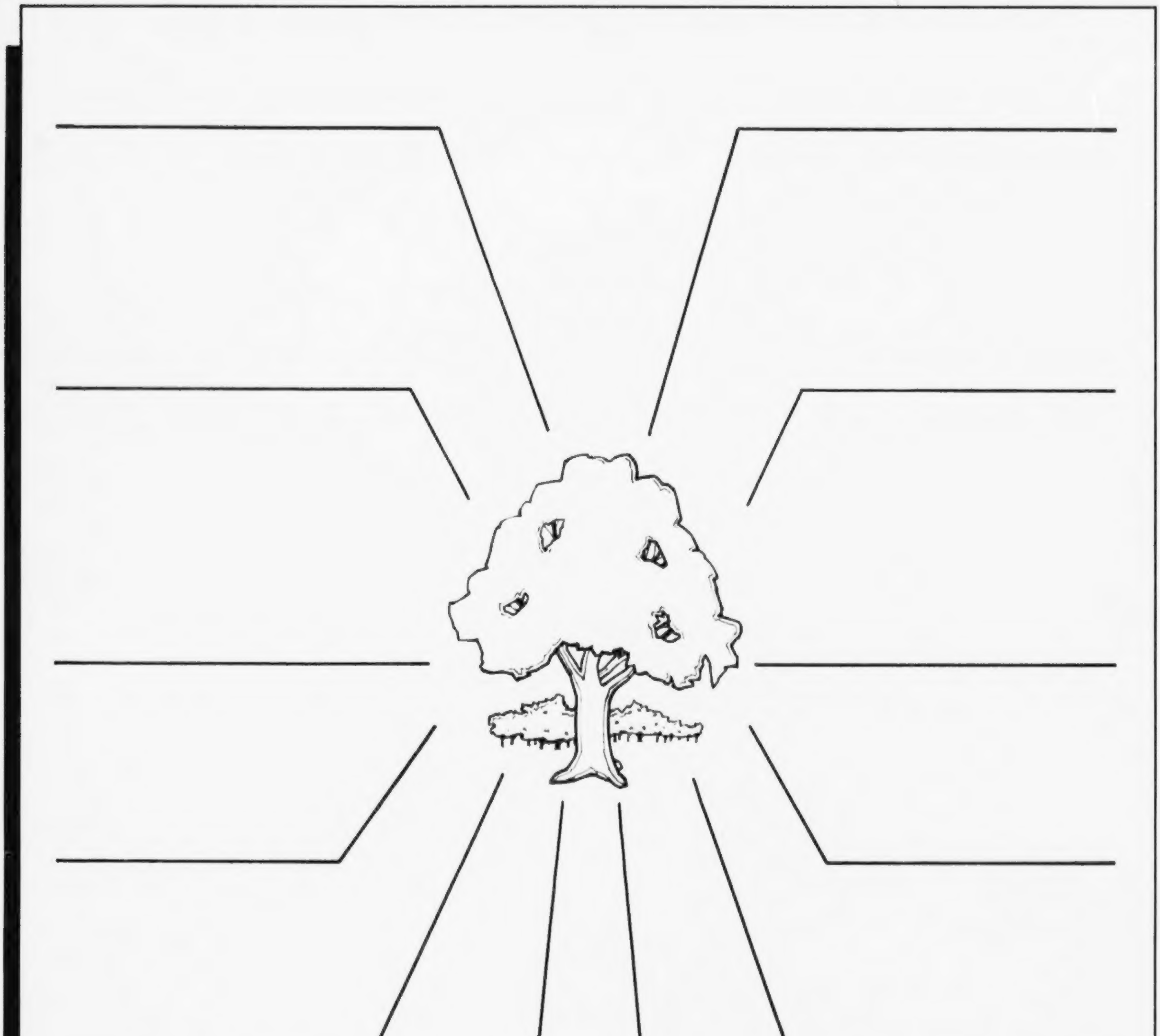
2. Have students write a story about what life in a forest would be like if we had no decomposers or scavengers as recyclers.

3. Have students explain how the recycling of leaves in nature is like the recycling of glass in human activities.

4. Plan a field trip to a forest or wooded area and have students observe and describe as many examples as they can of nature's recycling process.

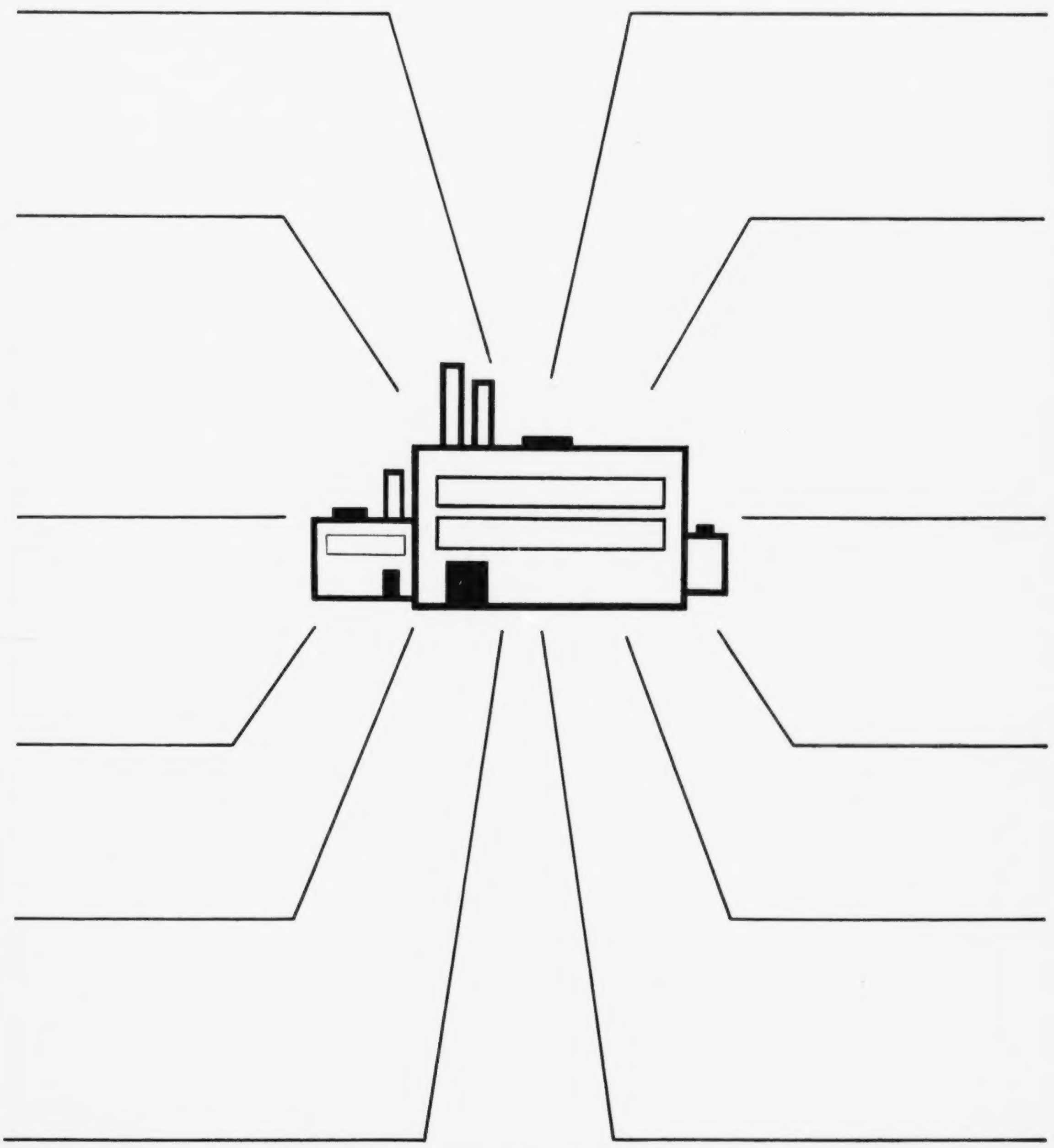
FOREST WEB

Directions: On the horizontal lines below list as many things as you can that are associated with a forest.



FACTORY WEB

Directions: On the horizontal lines below list as many things as you can that are associated with a factory.



NATURE'S SANITATION CREW

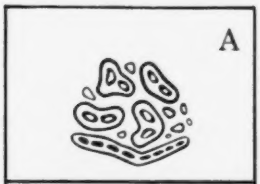
Some plants and animals clean up waste produced in nature. These plants and animals are called scavengers and decomposers. They eat dead plants and animals and they eat their waste, such as fallen leaves and dung.

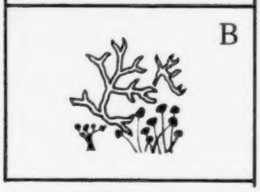
SCAVENGERS can be insects including beetles, ants and termites; or they can be birds, such as vultures, crows and seagulls; or they can be mammals such as raccoons, rats and bears.

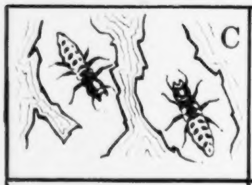
DECOMPOSERS include many types of bacteria and also fungi which take the form of molds, mildews and mushrooms. Bacteria are so small that you need a microscope or magnifying lens to see them, because they are tiny cells. Fungi are easier to see than bacteria because they are larger and are often more colorful. Bacteria are so tiny you could get millions of them on a fingernail.

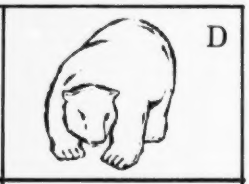
Directions: In PART I below, write the word, "SCAVENGER," over the pictures of scavengers and the word, "DECOMPOSERS," over the pictures of decomposers. In PART II below, number the pictures according to the order in which they happen in nature.

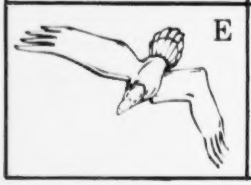
PART I

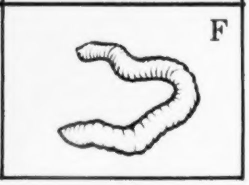




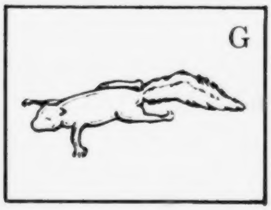








PART II



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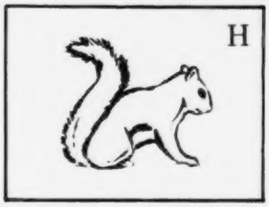

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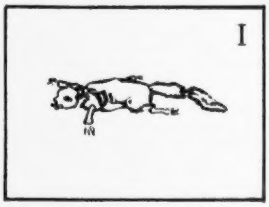

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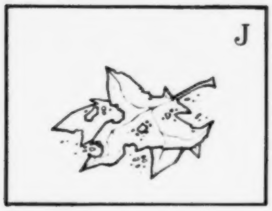

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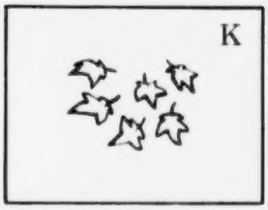

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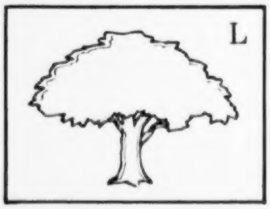

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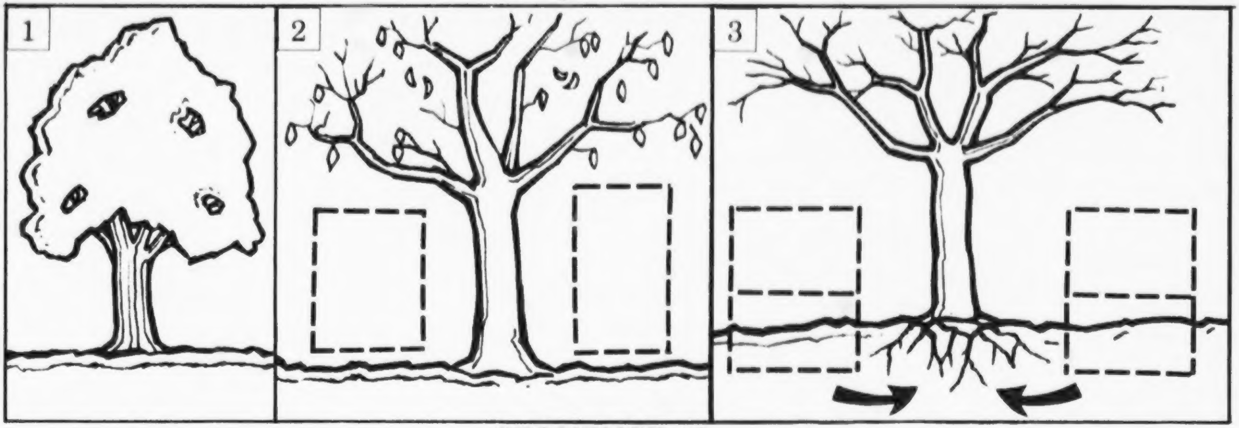
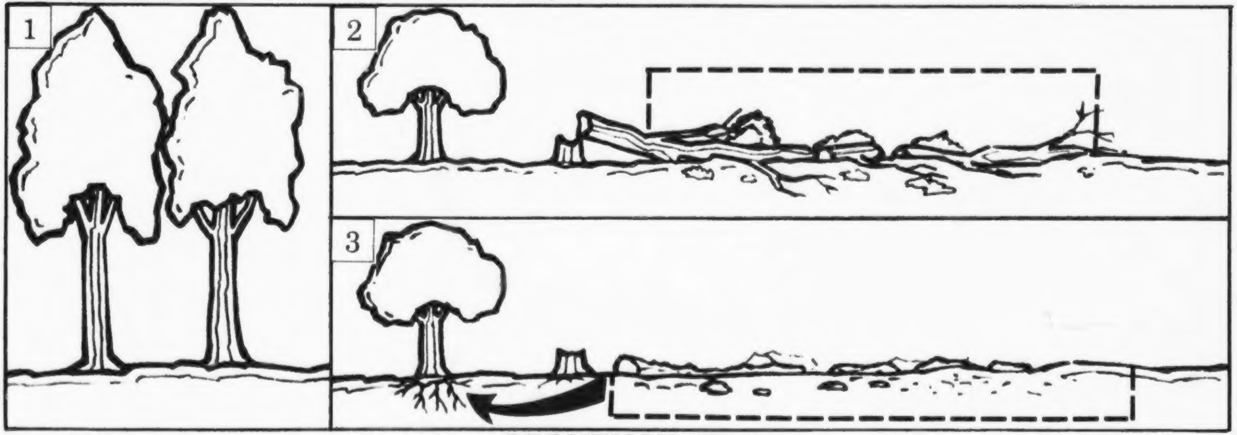
NATURE'S RECYCLING PROCESS

Directions: In the dotted line boxes in the pictures below, put the letter(s) of the plants or animals or waste material shown on the handout, ***Nature's Sanitation Crew***, in order to show what is happening in the pictures.

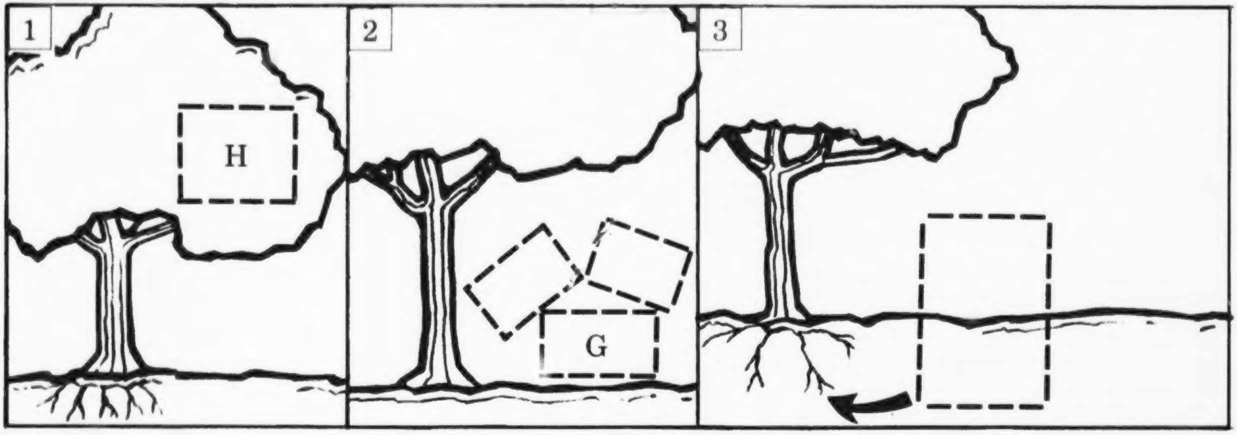
SEQUENCE #1



SEQUENCE #2



SEQUENCE #3



DESCRIBING NATURE'S RECYCLING PROCESS

Directions: Refer to the handout called ***Nature's Recycling Process*** to answer the questions below.

1. What is being recycled in SEQUENCE I pictures? ______________________

2. What is doing the recycling in SEQUENCE I? ______________________

3. What is being recycled in SEQUENCE II? ______________________

4. What is doing the recycling in SEQUENCE II? ______________________

5. What is being recycled in SEQUENCE III? ______________________

6. What is doing the recycling in SEQUENCE III? ______________________

7. What do the arrows indicate in the third picture of each sequence?

   ____

8. In the space below, tell in your own words what is happening in one of the three sequences. Write out complete sentences.

   ____

   ____

   ____

   ____

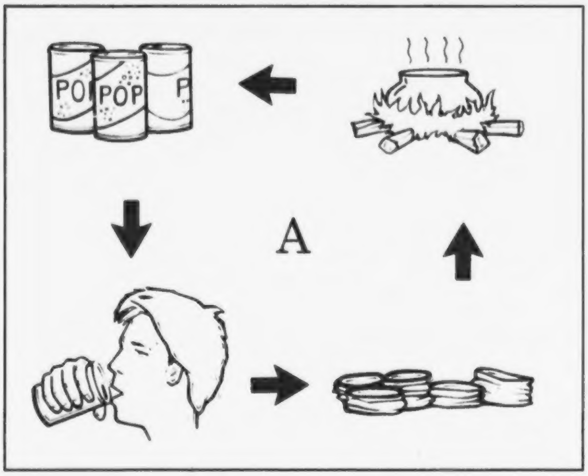
   ____

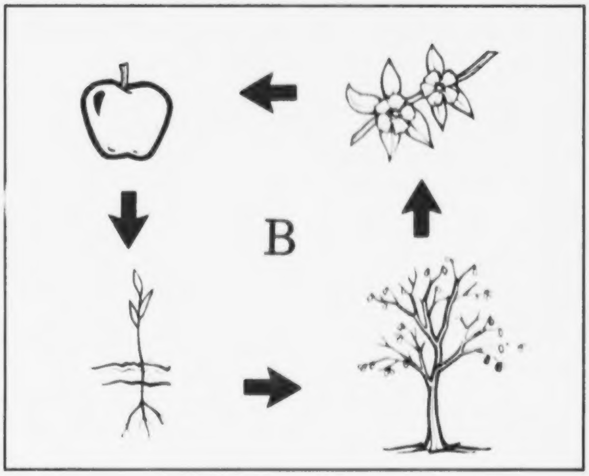
   ____

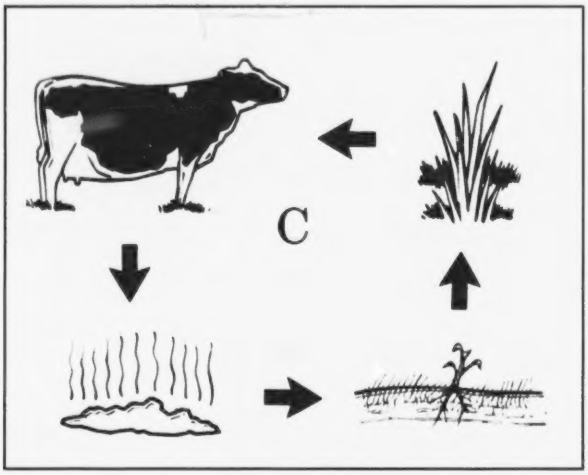
   ____

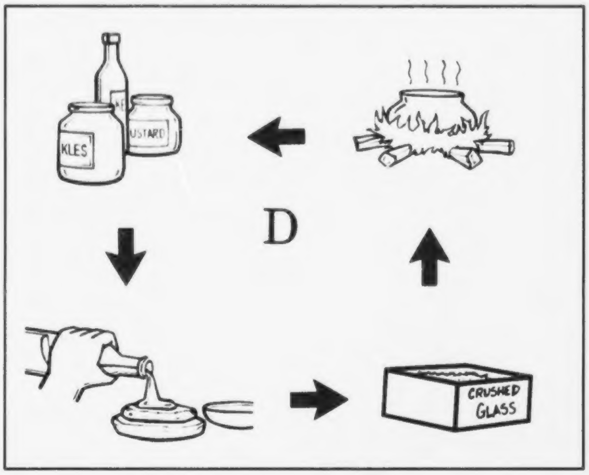
   ____

TWO RECYCLING SYSTEMS









Directions: Use the letters of the picture cycles above to answer questions 1-4. Use your own words to answer questions 5 and 6.

1. Which picture cycles depict nature's recycling processes? ____________
2. Which picture cycles show human recycling processes? ____________
3. Which picture cycle shows the recycling of plant matter? ____________
4. Which picture cycle shows the recycling of animal matter? ____________
5. What do you not see in picture C that is doing the recycling? ____________

   ____

6. What is doing the recycling in pictures A and D? ____________

   ____

"THE GREAT BREAKDOWN"

All living things produce waste. Nature's waste includes fallen leaves, tree branches, animal dung, dead animals and dead plants. These would make a big pile of garbage on the ground if they were not disposed of by scavengers and decomposers. Decomposers, such as bacteria and fungi, live in the soil and feed on very tiny pieces of waste matter. Scavengers such as bears, raccoons and rats can chew on the skin and bones of dead animals, leaving small pieces behind for decomposers to eat. Scavengers also produce dung for decomposers to eat.

Two important small scavengers are termites and worms. Termites help decomposers break down dead trees. Wood is hard for decomposers to digest because it contains a tough material called cellulose. Cellulose in wood is easier for decomposers to eat after termites have chewed it up or left it behind in the form of termite dung. Worms are another important scavenger because they digest soil through their bodies as they make tunnels in the soil. They leave behind, as worm dung, waste rich in nutrients that plants need to grow.

Worms show us that scavengers not only help get rid of waste, but they also recycle waste by passing it through their bodies and leaving it behind in the form of nutrients which plants need to grow. Nutrients, are "plant vitamins." They are drawn up by the roots of plants into their stems or trunks to enable them to grow. Nature's garbage contains many good things which must be returned to the soil so plants can grow.

COMPOST DWELLERS

CHAPTER 3

S.O.S.
SAVE
OUR
SOIL

INTERMEDIATE

Objectives

Students will be able to: (1) *describe* different types of soil and which type is best for plant growth; (2) *identify* what is needed to make compost (and hence enrich soil); (3) *explain* the role of bacteria in making compost. Students will improve their ability to *make deductions*.

Method

Students discuss the needs of plants and what makes soil good for plants. They distinguish good soil from poor soil by making deductions from previously given information and by observing a demonstration of the permeability of various soil samples. Students observe or participate in an experiment demonstration and *make inferences* about the relationship between soil, bacteria, temperature and the rate of decay of organic waste. Students complete handouts that explain what is necessary for composting waste and what types of bacteria are at work in compost.

Duration: two to four class periods (and two extra class periods if the experiment is conducted)

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 1.2, 2.3, 2.4, 3.3

Preparation

Gather samples of three or four types of soil: sand, clay, brown top soil and/or dark loam; round wire filter; measuring container with same diameter as wire filter; water. See "EXPERIMENT" explanation in activity description for other supplies needed if doing the experiment.

Vocabulary

areobic, annaerobic, bacteria, clay, compost, compostables, decomposer, humus, loam, noncompostables, nonporous, organic, permeability, porous, prefix, sand, soil, suffix, synthetic

Handouts

Munching Microbes, Decomposing Words

Procedures

1. Explain to students why soil is important for the growth of plants. Inquiry could proceed in the following manner. What do most green plants need to grow? (sunlight; water; air; nutrients including nitrogen, potassium, phosphorous and others which come from decaying plant and animal matter; material — soil — to take root in) Of these needs, which ones do you think soil can provide? (nutrients, water, matter to take root in) What determines how well nutrients and water are retained by soil? (the texture and permeability of soil) Explain the concept of permeability. Good soil is neither porous, (allowing water to go through it easily allowing nutrients to be carried away); nor is it nonporous, preventing the passage of water.

2. Show students three or four samples of different types of soil, one of sandy soil, one of clay, one of loam (rich dark soil), and/or one of brown top soil. Ask students how they could test to see which soil sample is the best for plant growth. Students have already discussed how the texture and permeability of soil is an important factor for plant growth, so they should be able to deduce a test procedure for water retention in the various soil samples. See what they suggest. Or, arrange materials for them to observe and to deduce possible uses for a test procedure. Display a fine mesh wire filter, soil samples, container of water and a measuring glass or beaker with a diameter the same size or larger than that of the wire filter. After students make suggestions you could do the following:

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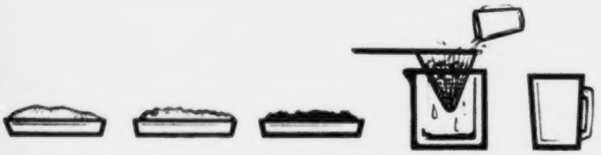
a. Put soil samples, one at a time, in wire filter and pour same measured amount of water over each of the samples.

b. Observe which soil sample is most porous (sand) and which is the least porous (clay); be careful not to incorrectly conclude that clay is porous when the water runs off its surface.

c. Record measurements of water lost into the container in each of the samples.



3. Discuss the results, inquiring which soil samples would be best for growing plants based on the water retention factor. Ask students what they think gives the brown soil and/or the loam its "just right" texture for water retention. (plant and animal matter called humus) Based on observations of the three or four soil samples, which one appears to have the most humus? Remind students of what color decaying plant and animal matter is — dark brown, black. This should enable them to identify loam as having the most humus, followed by the brown soil. Other than providing texture for the right permeability, ask students what else humus provides. (nutrients from decaying waste matter)

4. Ask students how plant and animal matter is turned into humus containing nutrients. (Something has to decay the plant or animal matter.) If you have already done the previous activity of this chapter, students should be able to identify decomposers as the answer to this question. Otherwise, explain that decomposers, living in the soil, help decay plant and animal waste.

5. Do an experiment, if you want, to demonstrate that bacteria live in the soil even though they cannot be seen. The experiment will also help demonstrate what type of matter (synthetic human-made materials) cannot be decomposed by bacteria and how bacteria work best in a fairly warm environment. If you do not do the experiment explain these facts and go on to Step 6.

EXPERIMENT

Collect five large glass containers such as beakers, pickle jars, etc. Prepare an *organic* mulch: decaying leaves chopped up and/or bread or small pieces of lettuce, etc. Prepare a *synthetic* mulch of bits of styrofoam, plastic, aluminum, even glass bits, but be careful of sharp edges.

a. In the bottom of four containers put a one to two inch layer of good fertile soil.

b. In three of these containers put a layer ½" thick of organic mulch. Make sure the amount and type of material is the same in all three samples. Set one of these containers aside in the classroom, this is CONTAINER #1 with only a layer of soil and organic material on top.

c. In CONTAINER #2 put more soil on top (a good 2" or so) and leave in the classroom. In CONTAINER #3 put the same amount of soil on top and put this container in a refrigerator.

d. In CONTAINER #4 (the one with soil but no organic mulch) put the synthetic mulch and cover with two inches or so of soil.

e. In CONTAINER #5 put only the organic mulch with no soil and let it sit in the classroom.

f. Leave all containers open to let air in. You may even stir occasionally. Add some water a couple times a week in the form of spray, just enough to dampen the samples. Keep all containers out of the sun.

g. After a period of a few weeks, examine the contents. Discuss the results.

- Spill out the contents of the containers. Examine them for signs of molds and fungi (fine white threads on leaves). Magnifying lenses might be helpful.
- In which container did the organic matter decay the quickest? Why?
- Why does placing soil on top of the leaves speed up the decaying process? (more bacteria and fungi)
- Why did the sample (#3) in the refrigerator not decompose as fast as sample #2? (Bacteria living in colder temperatures do not mul-

tiply or work as quickly as bacteria living in warmer temperatures.)

- Why didn't the synthetic matter decompose?
- When recycling synthetic materials (CONTAINER #4) ask students who or what must take the place of bacteria or fungi. (people, machines, chemicals used in machines)

NOTE: To make this experiment more than a "demonstration" modify it by proposing one or more of the following hypotheses to students and asking them how they could be tested. Let students observe the materials and supplies for doing the experiment. HYPOTHESES: Bacteria living in soil break down organic waste. Bacteria can break down only organic matter quickly; synthetic human-made materials can take a very long time for bacteria to decay, if at all. Bacteria living in warm temperatures multiply faster than bacteria living in cooler temperatures. Scientists can test for the effect of something without being able to see it (bacteria, molecules, etc.).

6. Ask students what they think people can do to improve soil quality. They can put decayed plant and animal matter into worn out soil, restoring humus to the soil. The process for doing this is called composting. Explain composting.
7. To help students understand what is required for making compost have them complete the handouts, ***Munching Microbes*** and ***Decomposing Words***.

Evaluation

Have students answer the following questions.

1. Explain the difference between compostable and noncompostable.
2. Why is compost important?
3. Look up the prefix "areo" and the prefix "an." Which type of bacteria, aerobic bacteria or anaerobic bacteria, can live without oxygen or air?

MUNCHING MICROBES

Directions: Answer the questions below.

1. To make compost out of organic material, decomposers such as bacteria and fungi must meet their needs to grow and reproduce. Circle the *three* words from the list below that are needs of decomposers. Then, on the line below the terms, write the one element that decomposer plants do not need which green plants do need.

TREES WATER WINGS FOOD AIR SUNSHINE

________________________ is needed by green plants to make food, but it is not needed by decomposers because decomposers cannot make their own food.

2. What type of things can decomposers eat for food? Circle the items below which decomposers can eat (things that are *compostable*). Underline items which you think decomposers cannot digest (things that are *noncompostable).*

___ APPLE CORE
___ DEAD FISH
___ ALUMINUM CAN
___ POTATO SKINS
___ WOOL RAGS
___ NEWSPAPER
___ APPLE WITH SKIN

___ RUBBER TIRE
___ LEAVES
___ COFFEE GROUNDS
___ FEATHERS
___ GLASS JAR
___ HAIR
___ DEAD BIRD

___ MANURE
___ SAWDUST
___ PLASTIC BOTTLE
___ BROCCOLI STALKS
___ LEATHER SHOE
___ LEATHER DUST
___ CORN COB

3. In the space to the left of each compostable item above put a "V" by items that represent vegetable matter and an "A" by items that represent animal matter.

4. What element from question #1 above helps decomposers eat animal and vegetable matter? Why?

____

____

DECOMPOSING WORDS

Many words in science are made from two words combined, or from using prefixes and suffixes to make new words. For instance, the word PHOTO is also a prefix meaning "light." The suffix PHILIC means "liking something." *PHOTOPHILIC* plants are plants that must have a lot of light to live. (In other words, they are plants that "like" light.) Are bacteria that live in compost this type of organism?

Directions: Read the paragraph and then fill in the blanks using a prefix and a suffix to make a word that will fit in the sentence. Choose prefixes and suffixes listed at the bottom of the page. Some answers will be used more than once.

Bacteria and Compost

As bacteria work to find food and to multiply in a compost pile, they create heat, so the temperature in a compost pile gets warmer. However, as the temperature gets warmer some bacteria that require cooler temperatures to live, begin to die. Other bacteria that require warmer temperatures to live begin to multiply. There are three types of bacteria living in compost. Each type lives in different temperatures.

1. ____________ / ____________ bacteria survive in the coldest temperatures in compost (between 30° and 50°F).
   (prefix) (suffix)

2. ____________ / ____________ bacteria thrive in moderate temperatures, not too hot and not too cold (between 70° and 100°F).
   (prefix) (suffix)

3. ____________ / ____________ bacteria live in the warmest temperatures (between 100° and 160°F).
   (prefix) (suffix)

4. A ____________ / ____________ is used to tell the temperature inside a compost heap.
   (prefix) (suffix)

5. Not all bacteria live on dead or decaying matter, some live on living things. The types of bacteria that live on dead things in a compost pile are called ____________ / ____________ .

PREFIXES

meso: middle or average

sapro: rotten dead matter

thermo: heat, hot

psychro: cold

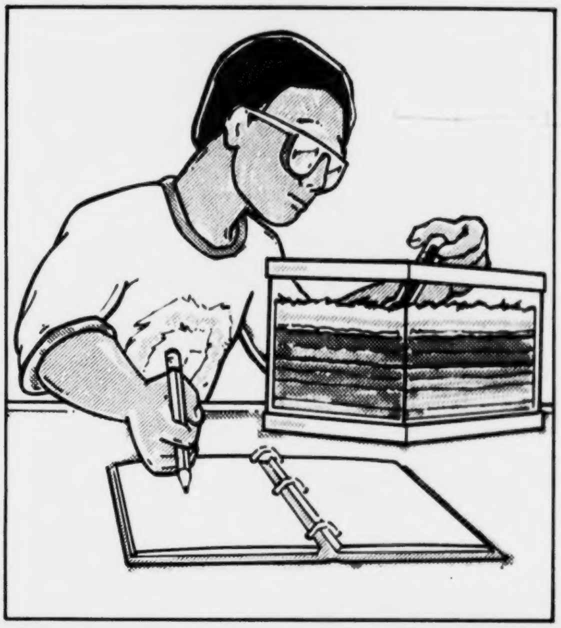
SUFFIXES

meter: an instrument used to measure something

philic: loving or liking something (used as an adjective)

phytes: plants having a particular place to live in (used as a noun)

THE TINY BEASTIE'S FEAST



INTERMEDIATE

Objectives Students will be able to: (1) identify factors in the decompositon of organic materials in compost; (2) *describe* how to make compost and how it enriches soil enabling plants to grow better. Students will improve their ability to *conduct an experiment.*

Method Students conduct an experiment to isolate variables in compost such as nutrient content, moisture content and the effect of earthworms. Students explain the purpose of comparing a control sample with test samples. They conduct an additional experiment about plant growth using the compost they made.

Duration: several class periods followed by weekly observations for three to six months.

Setting: classroom and/or outdoors

Subjects: Science, Language Arts

Curriculum Reference: 2.3, 3.3

Special Note This activity describes an experiment with three select variables in the composting process. Experiments using other variables are also possible; therefore, it is recommended that you read the background information to understand further possibilities for experimenting with compost. Also, the activity as described below may take up more time than you can afford, so you might modify it to experiment with only one or two variables, or you could simply decide to make a single compost heap, indoors or outdoors, and have students attend to it and observe changes as described in the background information. The activity description below is in two parts which could be accomplished separately. The first part is an EXPERIMENT WITH VARIABLES IN COMPOSTING and the second part involves USING COMPOST TO TEST ITS VALUE FOR PLANT GROWTH. Prior to doing this activity, it would help to have done one or both of the activities described previously in this chapter, especially the second activity, **COMPOST DWELLERS.**

Preparation Containers for compost samples will be needed, unless you decide to make the samples outdoors on the ground. Ten-gallon aquariums work very well; however, trash cans or even large buckets will do. If using trash cans or buckets, drill a few small holes in the bottom and set on blocks with a drain pan underneath. If doing all four samples suggested in the activity, four ten-gallon aquariums would be ideal, but two ten-gallon aquariums with a piece of wood creating two separate sections would do. You will also need the following:

- as much as 15 gallons of soil, depending on size of containers and number of samples you decide to test. (Soil should be brown, neither rich dark loam nor sand or clay.)
- medium size or small plastic bags for students to put garbage in to bring to class
- large tray and knife to chop organic items; container(s) for this mulch
- an abundance and variety of organic waste matter, provided by students from home or school or outdoors. (See list of items on pp. 66 of the Background Information of this chapter.)
- crushed limestone (not a necessity but may be helpful to eliminate pungent odors which may arise)
- manure or plant fertilizer
- a few earthworms
- a spray bottle for watering compost
- a thermometer
- writing material for recording information

©1988 Ohio Department of Natural Resources; sources: Barb Matheny, Wilson Vance Elementary (Findlay, Oh) and David Landis, DLPR

For the second part of the activity you will need milk cartons saved from the lunchroom, two for each group, and radish seeds or tomato seeds or any other fast germinating seeds.

Vocabulary animal matter, bacteria, compost, compostable, control sample, decomposer, dung, experiment, humus, nutrients, organic, scavenger, test sample, vegetable matter

Procedures

EXPERIMENT WITH VARIABLES IN COMPOSTING

1. Define compost with students. Ask what two major elements are needed to make compost. (decomposers and organic matter) Where do decomposers for compost come from? (soil and air) Where does organic matter come from? (waste in nature and garbage at home or at work) So, the first items needed to make compost are soil and organic matter. (This discussion can be facilitated by doing the previous activity, **COMPOST DWELLERS**, or parts of it.)
2. Provide soil and have students bring in organic materials from home or school, using plastic bags. Chop up pieces of garbage but do not make them powdery. Put vegetable matter and animal matter in separate storage containers.
3. Before putting soil and garbage items in the compost containers, put a layer (1/4" to 1/2") of crushed limestone and some coarse organic material on the bottom. (This helps prevent buildup of acid and water.) Add waste materials and soil to three containers in a sequence resembling that described on p. 65 of the Background Information. In a fourth container prepare waste matter and soil but *do not* add manure or fertilizer or any animal matter. (This will help test for value of specific nutrients.) Have enough soil to set aside a few large buckets full for use later in the year when compost is finished.
4. Discuss variables you will be testing:
   a. NUTRIENT DEFICIENCY: Ask students what they think the purpose was of not adding animal matter, or animal waste such as manure or fertilizer to one of the compost samples. (This is to test to see what happens when nutrients — nitrogen, phosphorous and potassium mostly — are lacking. Plant matter contains some of these but not as much as animal matter.)

   b. MOISTURE DEFICIENCY: Discuss the concept of variables, and explain how moisture content is a variable in composting. Ask students to consider the remaining three samples and how they could test to see the effect of moisture on compost. (They should suggest *not* adding any water to one of the remaining samples while they periodically water the others.) Ask students why they think moisture is important. (It helps bacteria or other scavengers and decomposers digest organic matter. To explain you could give each student a teaspoon of dry cereal and then one of wet cereal to compare ease of digestion and chewing.) Explain that students will be adding water periodically to the other samples. Remember to add water to the other samples just enough to make them like a wrung out sponge. Also make sure to measure and add the same amount of water to each sample. Ask students why this is important. (So the CONTROL SAMPLE and others can be validly compared with the TEST SAMPLE lacking moisture, and so all the other test samples have moisture because you are testing for things other than moisture deficiency among these.)

   c. EARTHWORM: In another sample test for the value of the earthworm in composting. Ask students how this could be done. Discuss. Then add earthworms to one of the remaining two samples.

   d. CONTROL SAMPLE: Ask students to list the VARIABLES that are represented by each test condition. These may be described as follows:
      a. testing for the effect of nutrients in compost (nutrient deficiency being a test variable)
      b. testing for the effect of moisture in compost (moisture deficiency being a test variable)
      c. testing for the effect of earthworms in compost (this scavenger being a test variable)

   One sample is left. Ask students if they should test for another variable such as air, or oxygen or a different type of soil in this sample. Discuss, until it is made apparent that there is a need for a control sample against which to measure the effect of the variables they are testing above. The control sample should be as follows to compare with these other variables. It is not lacking in nutrients nor moisture, and neither does it have earthworms. If students wanted to test for oxygen, or rather the lack of it, what would they have to do? (They would have to create another test sample including all the elements of the control sample but without allowing air to enter.) Ask them why you could not just plan to *not* add oxygen or air to one of the other test samples. (They would then be testing two variables in the same sample and hence would not know which factor caused a difference from the control sample.) The rule is that you can only test for one variable at a time, so all other conditions except one, between the control sample and the test samples, should be the same; otherwise you could not tell which variable was creating the change. (Of course, if your objective is to test in the test sample for the effect of two variables in combination against the control sample, then the two variables sample would be appropriate.)

5. In order to maintain the experiment, requiring approximately three to four months, do the following:

- Keep all samples, except the moisture deficient one, moist. Spray each with rain water (the best) or with tap water that has been set out for a few days to evaporate any chemicals that could kill bacteria.
- If the classroom air is very dry, you may want to cover your samples to keep them from drying out quickly; but in order to allow some air, prop covers open just a little bit.
- Allow air to circulate in each of the samples by poking and perhaps turning the samples each week. Or, you could ventilate the piles as suggested in the Background Information on p. 65.
- At the end of three months check to see if any of the samples are ready. See Background Information p. 65 for indications that compost is ready.

6. In small groups, or individually, have students keep records. As the compost is being made have students describe the color, texture and consistency of the organic ingredients and of the soil. Also, measure temperature of the contents and pH level if you wish. Temperature records are especially important for indicating if aeration is needed. (See p. 64-65 in the Background Information.) REMEMBER: the control sample and each of the test samples should be described individually.
7. When one of the samples is ready (should be the one with the earthworms first), have students make conclusions based on observations of all the samples. (The control sample should look close to the worm sample, while the nutrient deficient and moisture deficient ones should not look ready yet.)
8. Discuss the following hypotheses in light of their observations.

MAJOR HYPOTHESIS: Living things are adapted to particular environments which enable them to meet their needs. (Moisture, air, food, nutrients and an appropriate temperature allow bacteria to survive and multiply. Take away one of these elements, ie. moisture, and they will not survive as well.)

MINOR HYPOTHESIS: As plants and animals meet their needs they give off heat. Bacteria and other organisms act on dead plant and animal material reducing it to its components. Making good compost requires the right mixture of moisture, air and nutrients and an appropriate temperature. We can test for the existence of living creatures without being able to see them.

USING COMPOST TO TEST ITS VALUE FOR PLANT GROWTH

1. Ask students how they might test the following hypothesis: "Compost helps enrich soil enabling plants to grow better." You could begin by drawing their attention to the bucket of original soil you saved, asking why you saved it. You might compare color, texture and water retention rates between this soil without compost and this soil with a mixture of half compost. (See water retention demonstration in previous activity, **COMPOST DWELLERS.** Have the class make inferences about the effect of the two samples on plant growth.
2. Ask students which soil samples from the experiment would be the best to use. (The control

sample and/or the sample with the earthworms, if these samples came out the best as they should theoretically.) Remember, compost from the worm sample may be richer than the other, so you could test for the value of compost with worm dung in it versus compost without worm dung.

3. Divide the students into small groups. Have them decide who will take the responsibility for the following tasks in setting up the experiment:
   a. Punch holes in bottom of two cartons. Give each carton a group name or number; label one "with compost" and one "without compost." The one "with compost" could also be "with worm compost" in the case of one sample.
   b. Mix 1/2 cup compost and 1/2 cup plain soil together and place in first milk carton. (To test the effect of different quantities, you could have each group use different amounts including 100% compost alone.)
   c. Plant three seeds at the depth indicated on the package; water these with four tablespoons of water.
   d. Place one cup soil without compost in the other container.
   e. Plant three seeds in this container; water.

   Place each group's cartons in a sunny place. Have the students decide who will be responsible each day for the tasks of watering and recording data. All groups should be consistent about watering. Decide on the amount and frequency of watering that all groups should follow. This will vary according to the type of seeds planted and conditions in the room.

4. DISCUSSION:

- Which plants germinated first?
- Which plants grew quicker?
- How would you explain this in relation to compost samples that were tested?
- How can farmers or people who have gardens improve the fertility of their soil?
- How could composting help to reduce the amount of garbage we throw away and also be helpful to us?

Evaluation Write a descriptive paragraph based on notes kept during the first experiment to explain how garbage was turned into humus.

Chapter 4

Technology and Waste

TECHNOLOGY CHANGING WASTE

CHAPTER **4**

Changing Properties of Waste Matter

Waste materials can be changed in different ways depending on their physical and chemical properties. ***Physical properties*** of materials include size, weight, shape and texture, magnetic susceptibility, melting point and boiling point. ***Chemical properties*** of matter include susceptibility to oxidation *(rust)*, the ability to burn and the ability to dissolve in a given solvent under specific conditions. Changes in physical properties play a very important role in recycling processes associated with household recyclables such as cans, bottles and paper. Recycling these items typically involves breaking and/or melting them down and then reforming the materials into their original state. Chemical changes also occur in recycling. In chemical changes the chemical structure of a substance is changed, not just its physical form. Chemical change occurs, for instance, in newspaper recycling when ink is bleached out of old paper to produce white, printable recycled paper. Chemical changes are also important in hazardous waste recycling.

Another chemical change which much solid waste can be subjected to is combustion. Many solid waste materials are combustible. They can be burned, producing ashes and gases. The incineration of combustible waste materials reduces the volume of waste and can also be used to produce energy. Systems used to produce energy from waste or from waste-derived fuels are called ***energy recovery*** systems. Energy recovery is one way, like recycling, to get an extra use from resources which might otherwise be wasted.

The term ***resource recovery*** is used to describe a variety of material and energy recovery processes, in particular the recycling of household materials, the use of waste to produce energy, and the making of compost.[1] Composting is explained in the background information of the previous chapter. In the rest of the background information of this chapter, recycling and energy recovery will be examined.

The most commonly recycled household materials are paper, glass, aluminum, tinned steel (food cans), oil and certain plastics. Other materials such as copper, brass, rubber (tires) and lead (from batteries) can also be recycled. Old glass bottles and food containers are broken into pieces called cullet which is used to make new bottles and containers. This is an example of what may be called ***isoform*** recycling. The recycled materials are used to make the same kind of product that the materials were used in originally. Some plastic used originally to make food containers such as milk jugs is recycled into plastic landscape lumber. This is an example of what may be called ***heteroform*** recycling. Heteroform recycling is using recyclable materials to make a different kind of product from that which the materials were used in originally. Examples of isoform and heteroform recycling are listed below. Some heteroform recycling is quite ingenious, and people are constantly conceiving new products and processes.

GLASS: Glass is sorted by color, crushed into cullet and usually isoformly recycled to produce new glass containers. In heteroform recycling of glass, cullet is used in the manufacture of concrete, asphalt, brick, glass wool, terrazzo, artificial sand and polymer composite sewer pipe.

PAPER: Old newspapers can be isoformly recycled to produce new newsprint paper. High quality computer printout paper can be recycled to produce new computer paper. High quality paper products can also be heteroformly recycled to make paperboard products such as boxboard, linerboard and corrugated cardboard.

METALS: Tinned-steel food containers and aluminum beverage cans can be isoformly recycled to produce new steel cans and new aluminum cans. Scrap metal, both ferrous and nonferrous, from automobiles, appliances and machines can be heteroformly recycled to produce a variety of steel bar products — rounds, flats, and angles used to make construction materials.

PLASTIC: Plastic products are made from petroleum-derived resins. There are many kinds of resins with long names such as polyvinyl chloride, polyethylene, polystyrene, polypropylene urethane, acrylonitrile-butadiene-styrene. Plastics are usually heteroformly recycled to make items such as non-food containers, plastic landscape lumber, parking blocks and synthetic sleeping bag filler. Plastic food containers cannot be isoformly recycled. If recyclables are used to make new food containers they must be heated to a temperature high enough to insure that the containers will be sanitary. The Federal Food and

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[1] Composting represents a biological-chemical change in organic matter.

Drug Administration established a standard temperature for all recycled materials used in making food containers. When plastics used in food containers are heated to that temperature, the chemical structure of their resins changes, making them unusable.

RUBBER: There is much waste synthetic rubber to be found in used tires. Automobile tires must be very tough, so rubber is vulcanized in tire manufacturing, and becomes almost indestructible. It is very difficult to reverse the vulcanization process to make rubber that can be used to make new tires. Hence there is little isoform recycling of used tires. Tires are heteroformly recycled into arena flooring, rug underlay, and crumb rubber used in asphalt to improve road characteristics.

OIL: Lubricating oil can be isoformly recycled to make new lubricating oil or it can be put through heteroform processes to make road oil and fuel oil.

Manufacturing new products from waste materials is an industry. Recycling industries use many different industrial processes, depending on what waste material is used as raw material and what products are manufactured. Recycling manufacturers of consumer goods depend on a supply of waste materials they can use in their processes, and there is an ancillary recycling industry that collects waste materials and provides them to manufacturers.

In Ohio there are industrial facilities that use glass, paper and plastic to manufacture new products sold to consumers. There is also an Ohio recycling collection industry that provides glass, paper, plastic, steel and aluminum to recycling manufacturers throughout the world.

Recycling Processes

There are two processes in recycling that will be described generally: separation and transformation. The physical and chemical properties of wastes determine how wastes will be affected by these processes. ***Separation*** is sorting waste materials to be recycled from other waste materials. ***Transformation*** is physically and/or chemically changing the waste into something that is of use.

In separation, a physical property (or properties) present in one kind of waste, but not present in others, allows a person or a machine to distinguish them and then set them apart. For instance, a person may examine glass bottles and aluminum cans to determine their weight and flexibility, and then separate them accordingly. A crane equipped with an electromagnet can separate ferrous metals from all other surrounding wastes because only ferrous metals are attracted to a magnet.

In transformation, the physical or chemical properties of a waste will determine how it can be changed. Glass, aluminum and plastic can all be melted. Each is susceptible to a phase change (from solid to liquid) when its temperature is raised to its melting point. All three have different melting points.

Separation has to happen before transformation. Recycled wastes often go through several separation processes. At the first point of separation the desired materials are diverted from the waste stream. This is what happens when the household recycler places soda cans in a bin separate from the garbage cans. At later points of separation residual, unwanted wastes (called ***contaminants***) are removed from the now purer collection of recyclables. Thus when the household recycler takes soda cans to an aluminum can recycling center, a machine with an electromagnet will remove all the cans with steel sides from the pure aluminum cans.

If contaminants are still present when transformation starts, many things can go wrong, which is why separation must happen again prior to transforming the material. If colored glass is not separated from clear glass in a clear glass production process, the result is unwanted tinted glass. There are many kinds of plastics, each with different melting points and chemical structures. In some plastic transformation processes the plastics must be separated so that only one type of plastic is melted, or the result can be clogged machines and defective products. Contaminants in aluminum melting can cause a furnace to explode.

Separation Techniques

Separation of wastes is a very important part of recycling. It takes place through the efforts of consumers (waste generators), collectors and manufacturers.

Background Information

Source separation is separation of waste materials by type at the waste generation point (home, business, etc.) in preparation for recycling. This is usually done manually (***manual separation***) and followed by transfer of the materials to a recycling center or to curbside for pickup.

When machines are used to separate waste materials, the process is called ***mechanical separation***. Recycling centers separate aluminum cans from cans with steel in them with machines containing magnets. Because of the cooperation of recycling consumers in source separation, the materials that arrive at recycling centers are relatively free of contaminants and the mechanical separation processes used at recycling centers are relatively simple.

Not all waste is separated for recycling at its source by waste generators. Different generators' wastes are mixed up together and sent to sanitary landfills, or intermediate waste transfer stations, where they can still be separated for recycling before they are buried. Once the wastes are mixed together, however, the separation techniques that must be used are more complicated and expensive than those used at recycling centers. Large scale manual and mechanical techniques in different combinations are used to separate wastes for recycling at disposal facilities.

Wastes are also separated at some incinerators and energy recovery plants into noncombustibles (glass, metals) and combustibles (paper, fiber, plastic). Noncombustibles slow the rate of burning and can melt and clog furnace grates. A similar mix of manual and mechanical separation techniques can be used at burn facilities to increase burn efficiency and recover materials for recycling.

The different physical properties of waste materials make possible the use of a variety of mechanical separation techniques. The most common mechanical sorter at a recycling center is a magnetic separator. Magnetic separators (sometimes in the form of electromagnets for use on large metal objects) separate ***ferrous metals*** from ***nonferrous metals*** because ferrous metals (iron and steel) are attracted to a magnet and non-ferrous metals are not. Another property of matter useful in separation techniques is size. When mixed refuse is put into a machine of rotary screens, with hole-punched plates, materials can be partially separated according to the size of apertures in the plates. Small particles such as dirt, dust and ashes will pass through 13mm holes, food and other kitchen waste through 50mm holes and tin cans, bottles and paper through 200mm openings.[2]

Other important properties suited to separation techniques include weight, color, buoyancy and ability to be shredded. A machine called an air classifier can separate materials according to their weight using a stream of forced air to blow lighter items away from heavier ones. Optical sorters can separate clear and colored glass according to the degree of transparency of glass waste items. Flotation devices can separate materials which sink from items which will float. Often, before materials are separated by magnets, size sorters, color sorters, air classifiers and the like, they are crushed or shredded for more efficient separation in less space.

After recyclables are separated, collected, and freed of most contaminants, they are crushed, densified, boxed or baled for shipment in large quantities to manufacturers who use them to make new products. The manufacturers who buy them may subject them to additional decontamination to insure their quality as raw materials.

Transformation Processes

Waste materials go through various physical changes in the final stages of recycling. Most are subjected to gross physical changes. Aluminum cans are shredded into dime-size chips. Glass bottles are crushed into cullet. Plastic items are often ground into flakes. Paper is shredded, softened and reduced to a pulp. Reduction of the materials into smaller parts prepares them for a final decontamination process and allows a later phase change to be done with less energy than whole cans, bottles and paper sheets would require. After these changes the waste materials can no longer be easily identified as the consumer goods and packaging they once were. Their functional identity as containers and newsprint starts to disappear and their transformation has begun.

After the materials have been broken down, contaminants are separated and removed. In the aluminum and glass industry magnets and screens remove steel particles, plastic labels and other contaminants. At a paper plant, paper pulp is spun around in a refining device which separates staples, paper clips, metal and glass particles. The pulp must also go through washing on vibrating screens to remove ink and other chemicals. In the process of recycling two-liter plastic soda bottles, a flotation system is used to separate the heavier bottle flakes (PET) from the lighter base cup flakes (HDPE) that float to the surface. Then, to remove aluminum contaminants (such as bottle caps), the PET chips are put into a drum where an electrostatic charge causes the PET chips to cling to the drum while aluminum loses its charge and is thrown off.

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[2] John R. Holmes, *Refuse Recycling and Recovery* (John Wiley & Sons, 1981), p. 32.

In the gross physical reduction and separation stages described so far, physical properties of matter are important. In the next stage, ***physical changes in the state of matter*** are important, particularly when matter changes from a solid to a liquid and then back to a solid again. Aluminum, glass and plastic reprocessing provide excellent examples of these changes in the physical state of matter.

Aluminum chips are melted by furnaces from which the liquid metal flows into molds and solidifies again in the form of ingots. Rollers then squeeze these ingots into sheets which are shaped into new cans or other aluminum products. Glass cullet (after being mixed with virgin raw materials used in the making of virgin glass) is melted at very high temperatures. The molten glass is dropped into a mold and air is blown into the mold to form a container. As the glass cools, it hardens and a new glass bottle is produced. Some plastic materials are shredded and then melted into strands which are put into molds to harden into a product. Paper is made of compressed, dried cellulose fibers and does not go through a real change in state. It is shredded and mixed with water in a large machine resembling an electric blender. The fibers simply separate. The wet fibers are reformed into sheets on the papermaking machine. When the water is removed, paper is formed again.

Transformation processes differ from industry to industry. Some industries use labor-intensive techniques more than others. A variety of mechanical separation and transformation techniques are used even within the same industry. Different waste materials have different strengths and melting points so they require different shredding forces and different furnace temperatures. Yet some basic steps in the processing of most recyclable materials and their use in manufacturing products can be identified. These are: gross physical reduction, followed by final removal of contaminants, followed by the melting (or pulping) of matter (and often the addition of other raw materials and chemicals), followed by hardening (through cooling or drying) into shapes in molds. These represent the basic stages in the reprocessing of scrap aluminum, glass, plastic, steel and paper.

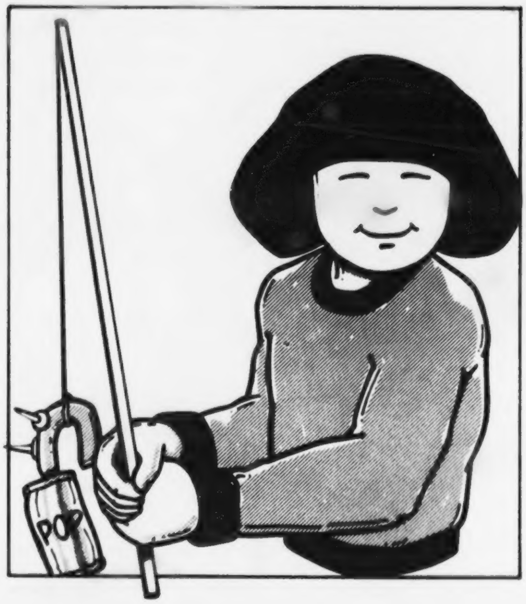
Energy Recovery

Waste which can be burned can be used as a fuel, hence energy can be recovered by burning waste. Combustible waste materials include vegetable matter, rags, plastics, paper and cardboard. When combustible waste is burned in energy recovery systems it produces heat which is used to produce steam for heating or for the generation of electricity. The mixed waste material that comes to a sanitary landfill can be burned with little additional processing except removal of some noncombustibles and shredding (for an even burn). Some waste matter (particularly paper and cardboard), can be formed into small pellets, called ***refuse derived fuel***, to be stored and used as a fuel supplement when needed.

Methane gas can be produced from garbage in a process called biogasification. Biogasification commonly occurs in landfills without human assistance. As aerobic bacteria eat the organic waste deposited in the sealed landfill, they also use up all the available oxygen in the landfill. Anaerobic bacteria then begin to digest the remaining waste, transforming it into methane gas and carbon dioxide. The combined methane and carbon dioxide found in landfills is called biogas. Because it is a gas, biogas follows the path of least resistance and accumulates in pockets in the landfill.

Biogas is explosive and dangerous if not properly controlled, but it is also possible to collect it for use as a fuel. The methane and carbon dioxide can be separated and the methane can then be shipped for use by gas providers or sent to energy plants for the generation of electricity or heat. Methane is the same as natural gas sold by utility companies for home heating. Biogas can also be produced in a more controlled fashion in an energy recovery system. In such a system the same anaerobic conditions found in landfills are created and speeded up by applying heat to a vessel containing organic waste and anaerobic bacteria.

CATCH 'EM IF YOU CAN



PRIMARY

Objectives

Students will be able to: (1) *sort* aluminum cans for recycling by using a magnet; (2) *classify* materials based on the property of magnetism. Students will improve *observation skills*.

Method

Students "fish" for various items with a magnet and discuss their observations. A pre- and post-test is given to students, requiring them to distinguish ferrous objects from nonferrous objects.

Duration: two c[illegible]s periods

Setting: classroom

Subject: Science

Curriculum Reference: 1.4

Preparation

Make a fishing pole out of a dowel rod, string and magnet. Label a box with the words "Save and Recycle Aluminum" and another box with the words "Save and Recycle Steel." Collect three empty tin cans (usually made of steel with a tin coating), three empty aluminum cans, two wooden blocks, several steel bottle caps, steel nails, a steel can opener and blue poster board. (Avoid bi-metal cans made of tinned steel and aluminum.)

Vocabulary

aluminum, magnet, magnetic, non-magnetic, steel, tin

Handout

What Will A Magnet Attract?

Procedures

1. Discuss the concept of magnetic attraction using a magnet and steel or iron object not pictured in the handout.
2. Distribute the handout, ***What Will A Magnet Attract?*** and have students complete it after explaining directions. Collect the handout when completed.
3. Display the objects (tinned-steel cans, aluminum cans, wooden blocks, steel bottle caps, steel nails and steel can opener) in random order in front of the blue poster board. Have students take turns trying to "catch" the objects with the teacher-made fishing pole. Observe and discuss magnetic and non-magnetic attraction as each attempt to fish for an object is made. As steel or iron objects are picked up by the fishing pole magnet, have student holding the pole drop the object into the box marked "Save and Recycle Steel."
4. Explain that aluminum cans can be identified because they are not attracted to a magnet. Put the three aluminum cans in the box marked "Save and Recycle Aluminum." Explain why we should save and recycle aluminum cans.
5. Ask students to save their aluminum cans at home and bring them to school so that they can be redeemed at a recycling center, if this can be arranged.

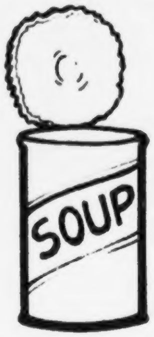
Evaluation

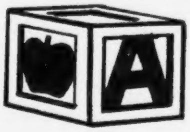
Distribute the handout, ***What Will A Magnet Attract?*** as a post-test for each student to complete.

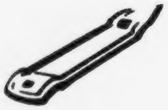
1988 Ohio Department of Natural Resources, source: Regina James, Hadden School (Painesville, Oh)

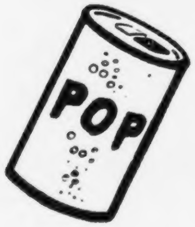
WHAT WILL A MAGNET ATTRACT?

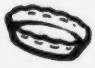
Directions: Circle the objects that a magnet will attract.

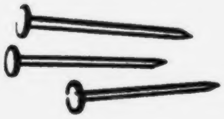












MAGNETS AND METAPHORS

CHAPTER 4

RECYCLING IS LIKE:
A.
B.
C.
D.
E.
F.

PRIMARY/INTERMEDIATE

Objectives Students will be able to: (1) *classify* metal containers based on magnetic properties and other observable traits; (2) *describe* how recyclables are collected and separated at a recycling center. Students will improve their abilities to *observe* differences and to *comprehend written material.*

Method Students listen to explanations about recyclable metals and then work in groups, using trial and error and their senses to sort and separate aluminum cans from other metal cans. They make a chart to describe the physical characteristics of three types of recyclable cans. They listen to or read a story about recycling and then answer questions that test their comprehension of the story. They explore metaphors for recycling and they *write* a story.

Duration: two to four class periods

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 1.1, 1.4

Preparation writing materials and rulers; enough small magnets for each student, or each group of students; five cans for each group: two aluminum (for example, pop cans), two tinned (for example, soup cans) and one bimetal can (tuna fish cans are often bimetal).

Vocabulary aluminum, bimetal, magnetic, metaphor, narration, nonmagnetic, tinned-steel

Handout ***Sure Thing Can Identification; The Can Man; Understanding Recycling***

Procedures

1. Discuss the importance of recycling metals. (conserves energy and nonrenewable resources)

2. Tell students that cans are recyclable, but that some are easier to recycle than others. Hold up samples of the three major types of cans: an aluminum can, tinned can (these are really 99% steel with a thin coating of tin) and a bimetal can. Explain that bimetal cans have an aluminum top and a steel body. Explain why it is harder to recycle bimetal cans. (The two types of metals must be separated.) REMEMBER: "Bimetal" *does not* refer to a can that has two metals combined to form an alloy.

3. Observe how cans are very similar in appearance and yet are different in composition. Explain why different types of cans need to be separated before they can be recycled.

4. Divide the class into small groups supplying each group with magnet(s) and five cans. Tell groups you want them to separate aluminum cans from the collection of cans they have. Ask them how this can be done. (Some types of metal have magnetic properties and others, such as aluminum, do not.) See which group(s) discovers the aluminum cans first by using the magnet to sort out tin and bimetal cans.

5. After each group has distinguished the three types of cans at their table, have one person in each group make a chart with three headings ("Aluminum," "Bimetal," "Tinned") along the top of the long side of a piece of paper. Draw lines to the bottom of the page separating each category. For identification description #1, have students write "not attracted by magnet" under Aluminum and "attracted by magnet" under Bimetal and Tinned.

©1988 Ohio Department of Natural Resources; source: Della Ewalt, Middletown Litter Control Program (Middletown, Oh).

Aluminum	Bimetal	Tinned
1. not attracted by magnet	attracted by magnet	attracted by magnet
2.		
3.		
4.		
5.		
6.		

Ask students to look carefully at the cans, holding and feeling them as well, to discover what else makes these three types of cans different from each other. Have them list as many traits in each column as they can. Check with handout, ***Sure Thing Can Identification***, to verify their findings.

6. Read the story, ***The Can Man***, to students or pass it out for them to read along with you. After finishing have them answer orally or in writing the questions on the handout, ***Understanding Recycling***. Be sure to explain what "metaphor" is before asking students to complete the handout. (A metaphor is a comparison of one thing for another.)

Evaluation Have students write their own story about a can that is taken to a recycling center. Instruct them to use a narrator to tell the story.

ALUMINUM	BIMETAL
* 1. Is *NOT attracted* by magnet	* 1. Is *attracted*
* 2. Almost all of these cans say "All Aluminum Can" on the side	* 2. Bottom has
* 3. No seam	3. If you look cl is not finel also usually
* 4. If the bottom of the can is round and shiny, then it is aluminum	4. (May or may
5. Shiny, silver, smooth	
6. Light weight	
7. Aluminum cans, if you look closely, are *finely* brushed on the bottom	
8. Printing is usually directly on the can as opposed to on a paper label.	

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* Excerpted from *A-Way With Waste* (Washington State: Departm

* "SURE THING" CAN IDENTIFICATION

	TINNED-STEEL
oy magnet	* 1. Is *attracted* by magnet
a rim	2. Has a seam
losely, the bottom y brushed. It is spray painted.	3. Heavier weight than aluminum
not have a seam)	4. (Usually has rings or ribbing on the can and normally has a paper label.)

NOTE: EXTRUDED STEEL CANS HAVE NO SEAM, ARE LIGHT WEIGHT AND HAVE NO RIM AT BOTTOM. MAGNETISM IS THE ONLY RELIABLE TEST FOR THESE.

ent of Ecology, Litter Control and Recycling Program, 1984), p 163

THE CAN MAN

Hi! Let me introduce myself. I am an aluminum can. My name is Canbe Recycled, and I'm here to tell you what happens when I meet the Can Man.

If you want to change the way you look, what do you do? (change clothes, make-up, etc.)

When you want to buy new clothes, where do you go? (store, etc.)

When we beverage cans want to change our appearance, we do it a little differently—and we depend on people like you to help us. Let me explain by telling you about the first time I met the Can Man.

It was a warm day, and I was resting in the grass after someone had finished drinking my soda pop and tossed me there. I was getting hot and afraid someone might kick me or throw me in a trash can never to be seen again.

Suddenly, my thoughts were interrupted by the voice of a man saying, "What have we here? A throw-away can? You can't lie here in my yard!"

Well, Pete Neat picked me up and took me to his garage where he had a big trash bag sitting in a box.

I was plenty scared, I tell you!

"Don't be afraid, little can," he said, "I'll take you to the Can Man and get you some new clothes. We'll just recycle you. Won't that be nice?"

Then he put me into the bag with a lot of other cans like myself.

I didn't know what recycle meant, but I liked the idea of new clothes.

The next day, Mr. Neat took all of us to what he called a recycling center where we met the Can Man. All of us were weighed, and Mr. Neat got some money for taking us there.

"Good-bye cans," he said, "I hope you like your new clothes." And away he went.

After he left, we cans were placed on a big moving belt and we passed under a magnet. All of us aluminum cans moved right over the top, but a few steel cans that were there by mistake were attracted by the magnet and were dropped away from us.

THE CAN MAN (cont.)

At the end of the ride, we all went into a shredder where we were cut up into little pieces so we would take up less space. It felt a little funny, but it didn't hurt a bit.

Next we went into something called a smelter where we were melted into pure aluminum. Do you know that this process saves 95% of the energy needed to make new aluminum from bauxite ore? And the reused aluminum is just as good as new metal!

Once we were liquid metal, we got our new clothes—that is, we were formed into new products. I became a can again, but some of my friends became aluminum foil, and some became baking pans and TV dinner trays.

Tomorrow I will go to the beverage company to be filled and taken to the store for you to buy, but today I wanted to explain to you about the Can Man, and how you can help all of us aluminum products get new clothes. That's what recycling means—it means to save natural resources by giving them new clothes and using them again. When we throw away, we waste.

All aluminum is recyclable. It takes only 24 cans to make a pound; if several of you would work together, you could collect lots of cans and other things made of aluminum.

You can identify aluminum by using a small household magnet. The magnet will not attract or stick to anything aluminum, but it will stick to anything made of steel. Remember: Magnets STICK TO STEEL.

I guess that's all I wanted to tell you today—except that we cans, just like you, really love to get new clothes.

When you see us lying around empty, please recycle us so we can have new clothes to wear. Otherwise, we get buried in landfills or we become ugly litter in yards and streets.

We're counting on you to help clean up the environment, to save landfill space and to save natural resources all at the same time by recycling. So pick me up the next time you see me.

UNDERSTANDING RECYCLING

Directions: For questions 1-5, put the letter of the correct answer in the blank to the left of each question. There is one best answer for each question. Then write out answers to questions 6-9.

_____ 1. The Can Man represents: (a) a recyclable can; (b) the person who saves cans; (c) the person who recycles cans to make them new again; (d) the person who changes clothes.

_____ 2. Canbe Recycled is: (a) the narrator of the story; (b) an aluminum can; (c) a recycling machine; (d) "a" and "b".

_____ 3. As Canbe Recycled was placed with other cans, they moved up a belt to be separated from tinned cans and bimetal cans by a: (a) magnet; (b) shredder; (c) water; (d) "b" and "c".

_____ 4. When Canbe Recycled talks about getting new clothes, this is a metaphor for: (a) shredding cans; (b) the recycling process; (c) saving energy; (d) looking funny.

_____ 5. When you recycle cans, you: (a) save landfill space; (b) are littering; (c) save scarce resources; (d) "a" and "c".

6. What is a "narrator" as mentioned in question 2 above?

____

____

7. The "metaphor" in this story could be stated as follows:

Recycling is compared to ______________________________

____

8. List other metaphors you can think of for recycling.

a. Recycling can be compared to ______________________________

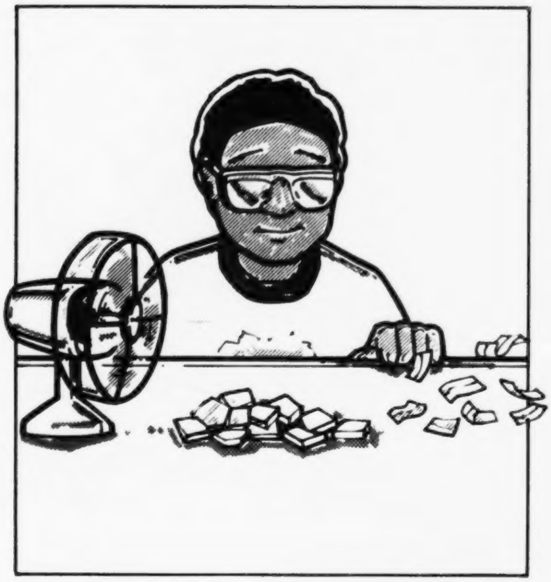
____

b. Recycling can be compared to ______________________________

____

SEPARATION MANIA

CHAPTER **4**



INTERMEDIATE

Objectives Students will be able to: (1) *describe* the function of various separation techniques in recycling processes; (2) *make deductions* from data to describe how physical properties of matter enable various separation techniques to be used. Students will improve their ability to *solve problems.*

Method Students describe physical properties of ten waste items on a data sheet. They are presented with several mechanisms that can be used to separate these items and are then directed to make deductions from the information sheet to *design* a separation process in stages, using the mechanisms that had been introduced previously. Students work in pairs or small groups to compete for the most efficient design which is put to the *test* for classmates to observe and to be judged.

Duration: several class periods

Setting: classroom

Subjects: Science

Curriculum Reference: 1.1, 1.4, 1.6

Preparation rulers, metric scales, a magnetic device (preferably a bar magnet which could be attached to a flat piece of wood), a small fan with two speeds or a hair dryer with two speeds, an aquarium tank or other large vessel for water, a size sorter (a cardboard box at least 1′ by 1′ with 2″ square holes cut in the bottom), another cardboard box with flaps taken away but no holes in it; for each pair of students or for each small group, have the following items: aluminum can, tin can, several used or unused staples, pieces of paper or pieces of cardboard, piece of wood, styrofoam container, plastic two-liter bottle and the cup part from the bottle, an orange peel, some steel bottle caps. Have extra pieces of paper or cardboard on hand.

Vocabulary properties of matter, recycling, sorting techniques

Handout ***Properties of Waste Objects***

Procedures

1. Discuss the concept of properties of matter, ie. size, shape, weight, susceptibility to magnetism. Discuss the importance of sorting materials according to type before they can be recycled. Show students the pieces of paper and staples. Explain how these often end up together at paper recycling plants and can be separated based on the physical property of magnetism in staples.

2. Explain how all of the items in this activity often end up at refuse facilities such as landfills and incinerators. Sometimes materials which are combustible and organic are separated from those which can be recycled or cannot burn.

3. Divide the class into pairs or small groups. Give each pair or group a set of items mentioned in the **Preparation**. Discuss some physical properties of the items.

4. Pass out a copy of the handout, ***Properties of Waste Objects***, to each pair or group of students and have them complete it. To do so, they will need to test the items in various ways in order to make choices on the handout. For this, have rulers, a tank of water, a magnet, a box with holes, and scissors at their disposal in various places throughout the room.

1988 Ohio Department of Natural Resources, source: David Landis, DLPR

5. After the charts have been completed, discuss answers.
6. Display on a large table space the magnet, the small fan or hair dryer, the vessel of water, the size sorting device (box with holes), scissors and cardboard box.
7. Based on information completed on the handout assign the following task to each pair or group of students.

   GOAL: Use the equipment to construct a process for separating all ten items individually. Do this by designing separation techniques in a series of stages. You must begin with all ten items in one pile bunched up close together on the table. You can pick up items to place them where you want them to go each time you make a separation, but you cannot separate them with your hands while using a separation technique. The group that separates the items most efficiently, i.e. in the fewest stages or with the most success, wins.

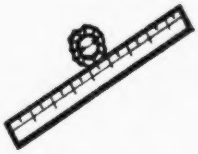
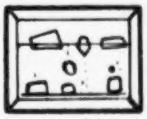
   EXAMPLE: You could do the following demonstrations for students to give them ideas. Ask students, based on their information sheet, which items should float and which will not. Put all ten items, as your first stage in the process, in the water. Put those that floated on the table in a separate bunch from those which did not float. This represents the first stage or step to be counted in the process. The next step(s) must involve sorting items from each of the two piles. Eventually you want to separate each item individually. The individual separation of one item from the rest could happen in a first step depending on design. Do another demonstration. Use scissors to make a pile of shredded plastic (from the bottle) and of shredded paper. The shredding process represents only one stage although two types of material have been shredded. Set the fan on the table in front of the pieces of paper and plastic. Put the cardboard box at end of table. Turn the fan on at a distance from the pieces and at a speed which will blow only paper into the box (or perhaps only the plastic if the paper is wet from having been in the water). Now you have separated these two items in two steps including the shredding process. You have eight more items to separate. Explain that you have deduced this step based on information about the weight of the materials listed on the handout. One important technique would be one that separates the items into three instead of two piles. You may also want to judge designs based on energy efficiency by creating a scale of energy required to use the various pieces of equipment. The team using the least energy could be given a prize.
8. Now direct pairs or groups of students to look carefully at their information sheets, and design stages in a process to separate all of the materials. (You could allow them to test parts of their designs as they create them, but this will require more time and perhaps more waste materials to do so, as material like paper could be destroyed in testing.)
9. Have each pair or group of students present their process to the class and judge which is the most efficient and/or energy saving.

Evaluation

Have students explain what the following terms mean and why they are important for recycling processes.

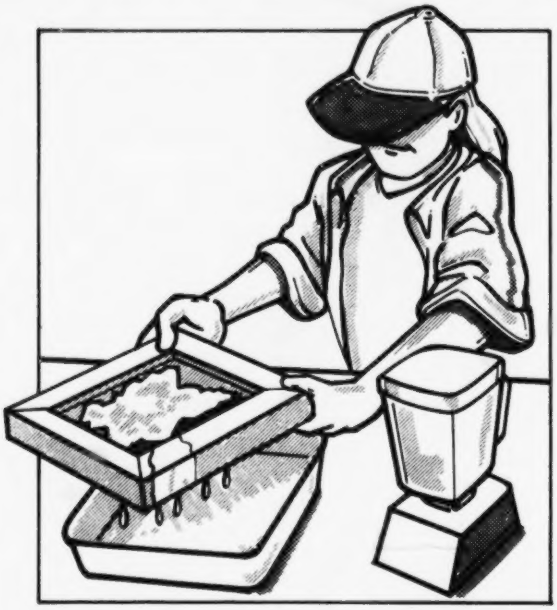
Air Classification System
Magnetic Separation Device
Water Separation System
Size Sorting Device

PROPERTIES OF WASTE OBJECTS

NAME OF WASTE OBJECT	 SIZE length × width	WEIGHT ounces	MAGNETIC	NONMAGNETIC	 FLOATS	SINKS	SHREDS	DOES NOT SHRED EASILY

RECYCLING PAPER

CHAPTER **4**



INTERMEDIATE

Objectives

Students will be able to *describe* physical changes required for the recycling of paper. Students will improve their ability to *manipulate materials and equipment.*

Method

Students use screens, blender, scissors and other equipment to make rough recycled paper sheets from a paper pulp mixture. They read and *follow directions* to guide them through the process.

Duration: two to three periods if doing the basic procedure

Setting: classroom

Subject: Science

Curriculum Reference: 1.1, 1.5

Preparation

Numerous items will be needed and alternative ways of doing the activity require different items. So read over the steps in the **Procedures**, including "ALTERNATIVE SUGGESTIONS", to decide which items you want to use from the list below. Items for the basic procedure are listed below with alternative or additional supplies listed in parenthesis.

- a container for pulp: dish pan, wash basin, bucket or large bowl
- something to grind paper into pulp: electric blender (egg beater—this enhances hands-on approach)
- scrap paper: white, uncoated loose-leaf notebook paper and paper towels work fine (Newspaper is easy to pulp but ink causes final product to be black. However, you could experiment adding 25% household bleach to the pulp solution. Bleach will also promote breakdown of heavier notebook and copy papers. Make sure you, and not students, handle the bleach in demonstration fashion if this is done.)
- wooden framed screen representing a paper mold: about 6″ square, could use nylon window screen and affix to back of wooden frame with staples or tacks. An old picture frame will do.
- (instant starch can be added to pulp mixture to make paper stronger, but is not necessary)
- scrap paper to dry recycled paper on (could use plastic wrap)
- (non-toxic food dye to add coloring)
- warm water in plastic jug or other container
- something to put pressure on wet pulp to squeeze out water: a piece of paper pressed against screen, or a wooden block made to fit over screen (You could also lay paper between two sheets of plastic and move rolling pin or pipe over it.)

Set up workstation(s) for students to work in pairs. A model workstation, in process order, could be as follows: aprons—box of scrap paper to be recycled—jug with warm water beside blender—container for pulp runoff and screen molds—scrap paper or wooden block—drying area. Cover all areas with a good thickness of newspaper to protect surfaces, this is a messy, but worthwhile, activity.

Vocabulary

paper pulp, physical properties, process, recycle

Handout

Instructions For Recycling Paper

Procedures

1. Explain how recycling requires physical changes in matter. What must happen to old paper to make new paper out of it? (It must be broken down into tiny fibers and mixed in water to make pulp.) The physical properties of paper such as its light weight, its fibrous texture and

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its ability to retain moisture (or other chemicals) in a mixture enable paper to be recycled.

2. Divide students into pairs or groups of pairs and set up workstations as previously mentioned.
3. Give each pair of students an instruction sheet to follow for making paper. Go over the instructions once and ask if there are any questions. (If you have modified the process, you may need to modify this sheet, make one of your own, or explain process orally.) Have students put on aprons before beginning.

   TIPS: Each pair of students should make two samples of paper so each student has a sample. As the pulp container fills up with pulp the screens could merely be dipped in this solution instead of making more pulp. However, this diminishes the hands-on nature of the activity through the use of the mixing device. Therefore, as the container fills up you could collect the pulp and store in freezer for future use. REMEMBER: do not pour pulp down a sink drain, wrap in paper and throw in the trash if you want to dispose of it.
4. When paper is dry have students make pictures on them with crayons or magic markers and tack on a bulletin board. REMEMBER: the paper students will have made is not slick, shiny white paper they usually write on. To achieve this quality at a paper recycling plant better machines are used and some chemicals are added to the pulp mixture.
5. In general, the recycled paper made in the classroom is thicker, darker and grainer than ordinary writing tablet paper. However, this classroom recycled paper may have special qualities for other purposes, such as packaging for eggs or cereal. You could have students make many pieces of recycled paper so they can experiment with scissors, glue, tape, etc. to see who can make the best box to protect an egg or to package some other item.

ALTERNATIVE SUGGESTIONS

Changes in Equipment

- Use egg beater instead of blender to make pulp. Be sure to tear scrap paper into very small pieces and to let these pieces soak overnight before beating.
- To promote paper breakdown when using a covered blender, add 25% household bleach to the pulp mixture. You may want to add this yourself as it can be harmful if not added properly by students.
- Instead of using paper or a wooden block to press water out of pulp on the screen, use a rolling pin, by placing wet pulp between two sheets of plastic.
- One way to enhance drying time is to place wet sheet of paper pulp between two sheets of blotter paper and iron with a clothes iron.
- If you want to demonstrate the de-inking process in newspaper recycling, add bleach to a pulp solution of strips of newspaper and water. Then strain pulp squeezing out ink in liquid and blend in water again.

Experimenting to Achieve Different Results

Discuss with students how various physical characteristics of recycled paper, such as thickness, color, texture and strength could be changed.

- Thickness: Increasing or decreasing the amount of pulp poured onto the screen will affect thickness (so will pressure applied to rolling pin if used to press moisture out). Increasing or decreasing the amount of scrap paper in water mixture will also have an effect.
- Color: To achieve a specific color recycle construction paper scraps of the color you desire. Or, add non-toxic fabric dye to pulp mixture.
- Texture and Strength: Add two tablespoons of starch to pulp mixture to see what happens.

Evaluation

1. Write the following steps from the recycling paper activity on the board and have students put them in correct process order.
   - mix paper and water into pulp
   - let paper dry
   - press water out of pulp
   - separate contaminants such as metal or plastic from paper
   - pour pulp over mold screen
   - shred paper into small pieces
2. Have students write a paragraph about the physical changes required to recycle paper. If

different variables (starch, bleach, dye, thicker pulp, etc.) were introduced and compared with the control samples, have students write up results.

3. Have students describe as many uses as possible for recycled paper.

INSTRUCTIONS FOR RECYCLING PAPER

Read the directions through once before beginning.

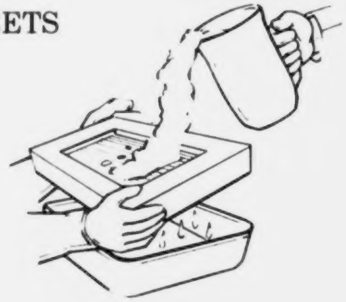
MAKING PAPER PULP

1. Take some scrap paper from the scrap paper box. Remove any plastic, staples or other materials which are not paper. Tear paper into small pieces. (They need not be tiny bits.)

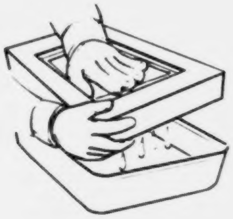
2. Fill the blender half full of warm water and put a handful of torn paper into it. IMPORTANT: Do not turn on blender with the lid off! Put lid on blender and blend paper until it turns to pulp. (This will happen quickly.)

PROCESSING PAPER INTO SHEETS

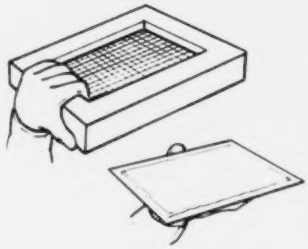
3. Hold the screen over the container while your partner pours pulp over the screen.



4. Hold a sheet of paper (or wooden block) over the pulp on the screen and press as much water out as you can.



5. Turn screen upside down on top of the sheet of paper (or wooden block) and lift screen away.



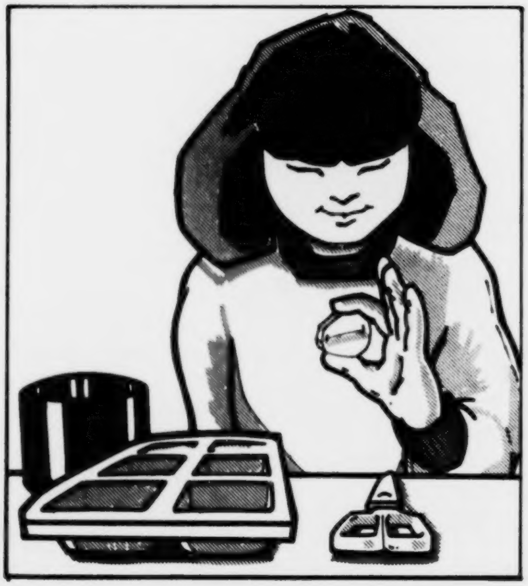
DRYING WET SHEETS

6. Take your paper (or wooden block) with wet sheets on top to the drying area.

7. Let your paper dry for about 24-48 hours. When dry, peel the newly formed sheet off the paper or wooden block.

RECYCLING PLASTIC

CHAPTER **4**



INTERMEDIATE

Objectives

Students will be able to: (1) *identify and describe* physical changes in matter which are required in recycling processes involving plastic, glass, aluminum and other metals; (2) *explain* why plastic is difficult to recycle. Students improve their ability to *observe changes.*

Method

Students participate in a demonstration to recycle plastic using the cup part of two-liter plastic pop bottles. They *manipulate tools* to cut plastic, to make an impression on a mold and to make decorative use of the ornamental piece of plastic made from the recycled plastic. They complete a handout using different words that represent different types of plastic.

Duration: two to three periods

Setting: classroom

Subjects: Science, Language Arts, Arts & Crafts

Curriculum Reference: 1.3, 1.5

Preparation

You will need the following:

- two-liter pop bottles with plastic bottoms
- scissors
- teflon-coated muffin pans
- non-stick kitchen spray
- conventional or toaster oven
- pot holder
- wash basin
- sealing wax stamp

For the language arts part of the activity you will need a plastic garbage bag and dictionaries. (It would help to have dictionaries that list words from organic chemistry such as vinyl, chlorine and polyethylene.)

Vocabulary

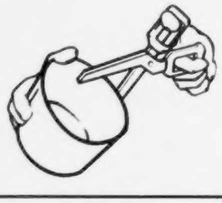
organic chemistry, petroleum, physical changes, plastic, prefix, recycling, suffix

Handout

Words in Organic Chemistry

Procedures

1. Discuss changes in the physical state of matter with students. Pay particular attention to the changing of solids into liquids through the application of heat and then changing back to a solid by diminishing heat. Have students think of examples: candle wax is first solid until wick is lit. Then it becomes a liquid form at the top of the burning candle, yet as wax runs down the side it escapes the heat thus hardening into solid form again. Make note that before dripping wax hardens completely it can be shaped without breaking. Other examples of heating materials, forming them into shapes while hot and then allowing them to cool into a solid state again include aluminum recycling of aluminum cans, glass recycling of glass bottles and the recycling of ferrous metals from old automobiles into steel rods used in concrete construction.
2. Divide students into groups of six. Have each group obtain some empty two-liter plastic pop bottles, and have them remove the bottom cups from these.
3. Using scissors, have students cut up the plastic bottom cups into small pieces (about 1/2 inch square). Do not use plastic pieces that have glue on them. At least ten pieces for each student in the group should be cut.



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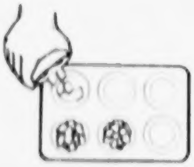
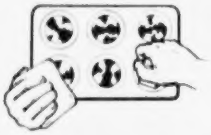
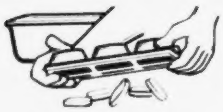
4. Preheat oven to 400°F. Spray the muffin pan with non-stick kitchen spray.
5. Students should place all of their pieces in one of the muffin pan cups. (About ten pieces of plastic are enough to cover the bottom of a cup, but add more if bottom is not covered.)



6. Place the pan in the oven. Check every few minutes. When plastic has melted, use pot holder to remove the pan from the oven.
7. One at a time, have each student from the group use the wax stamp to make an imprint on the plastic. BE CAREFUL NOT TO TOUCH THE PAN, IT IS VERY HOT!



8. Dip pan in wash basin full of cold water. Plastic pieces can be easily removed from the pan.



9. Repeat process with the other groups.

   REMEMBER: There are many different colors of plastic bottle bottom cups available. You may mix any colors you like. Be creative. The plastic pieces can be put on a necklace or used as ornaments. Different shaped pans can be found and used to create different shapes. (Be sure pan is teflon coated and used with non-stick spray.)
10. Ask students why only the bottom plastic cup part of the bottle was used in this activity. By observing the bottle they should be able to deduce that the cup part appears to be made from a different type of plastic than the bottle part. This means that the two types of plastic may have different physical and chemical properties. In terms of physical properties of matter, the translucent plastic bottle part melts at a much higher temperature than the bottom part. In terms of chemical properties of matter, the bottle part releases poisonous fumes if burned at high temperatures.
11. Note that one of the problems with plastic recycling is that there are many different types of plastic, requiring different recycling processes. So it is important to separate different types of plastic before recycling.
12. To help students understand the variety of plastics that can be made by combining chemical elements into other compounds and mixtures, give each student the handout, ***Words In Organic Chemistry***, to complete.

Evaluation

1. Have students list in writing the physical changes they made in the plastic cup to recycle it.
2. List these two words on the board with their definitions:

   ISOFORM RECYCLING - material is recycled to make the same or similar product

   HETEROFORM RECYCLING - material is recycled to make a different product

   Ask students: When the two-liter bottle cup was recycled in the activity, was that an example of isoform or heteroform recycling? Why? (heteroform recycling)

WORDS IN ORGANIC CHEMISTRY

Plastic two-liter pop bottles are made of two types of plastic. The bottle part is made of POLYETHYLENE TEREPHTHALATE (or PET). Can you pronounce these two words? (See bottom of page.) The cup part is made of HIGH DENSITY POLYETHYLENE (or HDPE).

1. What prefix is found in the word POLYETHYLENE? ____________________
2. What does it mean? ____
3. Therefore, POLYETHYLENE is a plastic material which includes ____________ units of ETHYLENE.
4. If a plastic material is called MONOETHYLENE, how many units of ETHYLENE does it have? ____________________

Plastic products are also made from materials with names resembling ETHYLENE, such as STYRENE and PROPYLENE.

5. What suffix do these three words share? ____________________________

   (This suffix refers to the way these types of plastic are made which gives them strength.)

6. If plastic made from STYRENE included more than one unit of STYRENE, it would be called ________________________________ .

Density relates to the compactness of matter.

7. What do the words *high density* mean? ____________________________
8. What does *low density* mean? ____________________________________

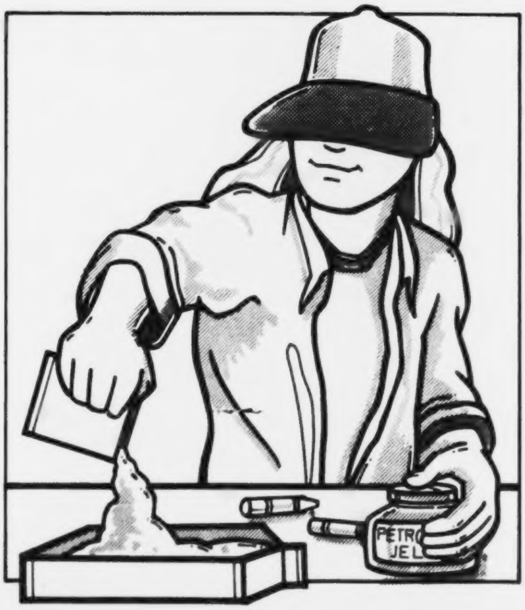
Compare a plastic garbage bag to the cup part of a two-liter bottle.

9. Which one is made of *low density* Polyethylene? ______________________
10. All of the chemical words used above can be found in an organic chemical dictionary. Why are they found in an organic chemical dictionary and not an inorganic chemical dictionary? (HINT: Look up words *organic* and *inorganic* and look up the word *plastic* to find out what plastic is made from.) Write answer on back.

POLYETHYLENE (päl′ ē eth′ əlēn′) TEREPHTHALATE (ter′ efthal′ āt)

THE SHAPE OF RECYCLING

CHAPTER 4



INTERMEDIATE

Objectives

Students will be able to: (1) *describe* the role of mold making in recycling processes; (2) *explain* why mold making requires a physical change in matter. Students improve their ability to *make analogies.*

Method

Students follow directions to *manipulate equipment and materials* to make an object by pouring melted crayons into a mold. Students observe and analyze the crayon recycling process and evaluate it. They interpret the process as analogous to the recycling of different materials.

Duration: two class periods during each of three days

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 1.3

Preparation

Divide this activity into three days or make adjustments in the descriptions below accordingly. Save old crayons and start collecting materials at the start of the year.

MATERIALS REQUIRED FOR DAY ONE:

old broken crayons (the scrap materials), hand pencil sharpeners or scissors, newspaper, two 1/2 pint milk cartons per group of two students

MATERIALS REQUIRED FOR DAY TWO:

plaster of Paris, water, petroleum jelly, one straw per group, paint paddle or other stir stick, two one-quart milk cartons per group, newspapers, whole new crayons with the paper removed, and scissors

NOTE: You may need to have five milk cartons on hand, per group, because some cartons may become damaged as molds are made and removed.

MATERIALS REQUIRED FOR DAY THREE:

both molds made in day two, chipped crayons from day two, a hot plate or similar heat source, rubber bands, a double boiler or old pan, hot pad holder, petroleum jelly

Vocabulary

analogy, evaluate, mold, physical changes, recycle

Handout

Evaluating a Recycling Process

Procedures

Before beginning activity, discuss with students physical changes in matter involving materials that can change from a solid to a liquid to a gas, depending on the application of heat. Show them how a liquid takes the shape of the container it is in. Then ask in what state(s)—solid, liquid or gas—is it usually easiest to make changes in the shapes of materials. (liquid since liquids take the shape of whatever container you put them in) Discuss concept of shaping material with molds, especially in the glass and plastic container industry.

DAY ONE: Students will work in groups of two. They need to sort the crayons by color and remove any paper on the crayons. Then have them scrape the crayons into slivers or chips using the hand pencil sharpener or scissors. Collect savings in cut-off milk cartons.

DAY TWO:

1. Students use scissors to cut away one side of one of their milk cartons. This will be called Carton A.

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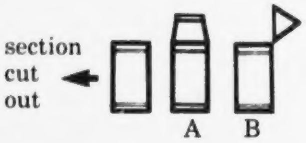
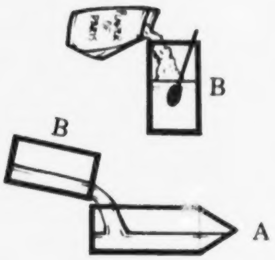
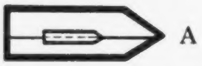
2. Students cut the top off the other carton (to be called Carton B).



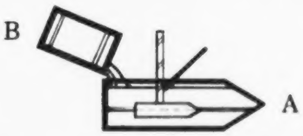
3. Students will fill Carton B half full of water. Slowly pour in plaster of Paris, stirring with a paint paddle or stick, until it is as thick as soft cream. Pour the plaster into Carton A until it is half full or at least 3 times deeper than the diameter of a crayon.



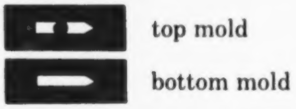
4. Have students cover the whole new crayon with a thick coat of petroleum jelly. Then place it in the plaster of Paris in Carton A – press into plaster until half the crayon is submerged lengthwise – let harden.



5. After the plaster has hardened, have students remove the crayon from the mold. Then they reapply petroleum jelly to the crayon and also to the top of the mold they just made. They will then replace the crayon in the mold. One member of the group will hold a straw on top of the crayon, while the other member pours a new mixture of plaster around the straw covering the crayon and mold they made in Step 4. This layer should be three crayons thick. As the mold hardens, students should press the newly forming mold around the straw with a tongue depressor or stick (or spoon) to make a depression. (Later this will act as a funnel.)

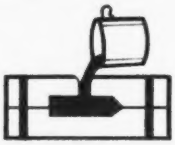


When the top mold hardens the two molds should be separated and the crayon removed.



DAY THREE:

1. Students will coat the molds with petroleum jelly, place both halves together and fasten with rubber bands.
2. The teacher will melt the crayon chips the students provide in a double boiler or old pan. (Let the students determine when enough "scrap" material is in the pan to make a "new" crayon.)
3. When the crayons have melted, the teacher will pour the liquid into the students' mold.



4. After the mold cools, the students can examine the recycled crayon.
5. To evalute their success have students complete the handout, ***Evaluating a Recycling Process***.
6. Students could design and make a cover for their crayon out of construction paper, etc.

Evaluation

Check students' answers to question #5 on the handout.

EVALUATING A RECYCLING PROCESS

1. List the physical changes that occurred to the old crayons during the recycling process. (Could be changes in color, size, shape, etc. and in physical state, i.e. solid, liquid or gas.)

2. Do you think your recycled crayon was a success? Why or why not?

3. How could the technique be improved to make a better crayon?

4. List other possible uses for scrap crayons.

5. **On the back of this page, explain how your process of making a mold, and how the problems you had, could be similar to the recycling of other materials such as glass, plastic and metal. Refer to encyclopedia to see how the mold process is used in making these materials.**

TO BURN OR NOT TO BURN

CHAPTER 4

INTERMEDIATE

Objectives Students will be able to: (1) distinguish combustible items of refuse from noncombustible items; (2) *explain* how refuse can be used as fuel; (3) *analyze* the consequences of burning garbage and *suggest alternatives.* Students will improve their abilities to *observe* demonstrations and to *hypothesize.*

Method Students make hypotheses about the combustibility of various refuse items and then observe demonstrations that test their hypotheses. They complete a handout to enhance their understanding of energy recovery.

Duration: three to five periods

Setting: classroom, outdoors

Subjects: Science, Language Arts

Curriculum Reference: 1.2, 1.5

Preparation Collect the following: an empty soup can for each waste item you decide to use in the demonstration, a candle, matches, tongs, pot holders. You will also need examples of different trash materials to be tested for combustibility (provision for seven items is made on the handout). Trash materials should include the following: some bits of paper, pieces of broken glass or small glass jar, a piece of metal can (might want to include aluminum and tin), piece of aluminum foil, some pieces of plastic and of styrofoam (NOTE: PLASTIC OR STYROFOAM SHOULD NOT BE BURNED INDOORS), and some organic garbage such as apple skins, orange rinds, cheese. For the additional demonstration, STEPS 6-9 in the **Procedures** description, you will need the following:

- outdoor barbeque grill;
- some type of model of steam generating energy mechanism (e.g. a can of water with a tight lid and small outlet hole for steam; hook up windmill toy close to hole to produce motion);
- cardboard strips and wood chips or shavings and paper (lots - enough to burn a while to generate steam in a vessel);
- plastic items and styrofoam;
- scales

Vocabulary air pollution, combustible, energy recovery, fuel, noncombustible

Handout ***Combustible or Not? Energy Recovery***

Procedures

1. This activity is a teacher demonstration. (You might wish to use goggles and have a fire extinguisher on hand for safety.) On a protected surface place the soup cans in a row with labels naming each of the items to be tested. Place waste objects to be burned in front of the cans. A pot holder and a pair of tongs should be available to grasp hot items.

2. Have students assemble in groups of three to complete a prethinking exercise. Give a copy of the handout, ***Combustible or Not?*** to each group of students. Ask them to predict and discuss which waste items in front of the cans will burn and which will not burn. Explain the terms "combustible" and "noncombustible." Encourage students to work together and to support their answers. After the prethinking exercise, students should be encouraged to observe a teacher demonstration.

3. Allow students to observe the burning or the noncombustibility of each item as it is held over the candle flame. Drop the burned or hot items in their respective cans after you finish testing them.

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4. Show contents of cans to students or dump contents out after they have cooled. Have students check their initial inferences to see if they were correct or not in each case.
5. Ask students why it is important to classify refuse into categories of combustible and noncombustible. If trash is combustible it can be burned to reduce landfill space. Since trash can be burned it can also be used to generate heat or electricity. If you can, continue with a demonstration outside to prove this, or move on to Step 10.
6. Outdoors, prepare two samples of fuel: one of paper and wood and another of 1/2 paper and wood and 1/2 plastic items. Make sure both piles weigh the same.
7. Set steam generating mechanism on grill and burn enough paper and wood to generate steam to turn the windmill. Time how long it takes to produce steam. Smother fire.
8. Then burn paper fuel with plastic material. Have everyone stand back so vapors are not inhaled. Time how long it takes to turn the windmill. You may also wish to collect the ash residue from the two samples and compare weight (and volume) before and after burning. Incineration reduces the weight of refuse as much as 75 to 80% in most cases.
9. Return to class for questions. Begin by comparing the two fuel samples. Which one generated heat the quickest? (should be sample with plastic as plastic burns hotter than paper or wood) Which sample created the most pollution? (sample with plastic) What type of pollution was this? (air pollution)
10. Explain the process of generating energy with steam by giving each student the handout, ***Energy Recovery***, to complete. Discuss and review student answers.
11. Mention to students that refuse can provide other sources of energy. Ask if anyone knows what these could be. A type of easily combustible gas called methane eventually collects in a landfill. This gas can be piped out, collected and used through natural gas pipelines. Composting is also a form of energy recovery because it provides stored energy in the form of nutrients which plants change into energy to grow.

Evaluation

Have students write out answers to the following questions:

1. Most metal and glass burn at such high temperatures that they are considered noncombustibles in the waste stream. Why is this a problem when disposing of these items? What could we do with metal and glass if we sorted it from the burnable trash? (Recycle)
2. When we burn refuse, what is one good environmental impact? What is one possibly harmful environmental impact? (Good impacts include saving landfill space and recovering energy. A harmful impact is the creation of air pollution if filtering process is not efficient.)

COMBUSTIBLE OR NOT?

Directions: Name the items of refuse and tell whether you think they will burn or will not burn by writing the word **combustible** (if the object will burn) or **noncombustible** (if the item will not burn) in the parenthesis to the right of each item name. Then for each object, tell why you said it was combustible or noncombustible.

ITEM: ( )

WHY?

ITEM: ( )

WHY?

ITEM: ( )

WHY?

ITEM: ( )

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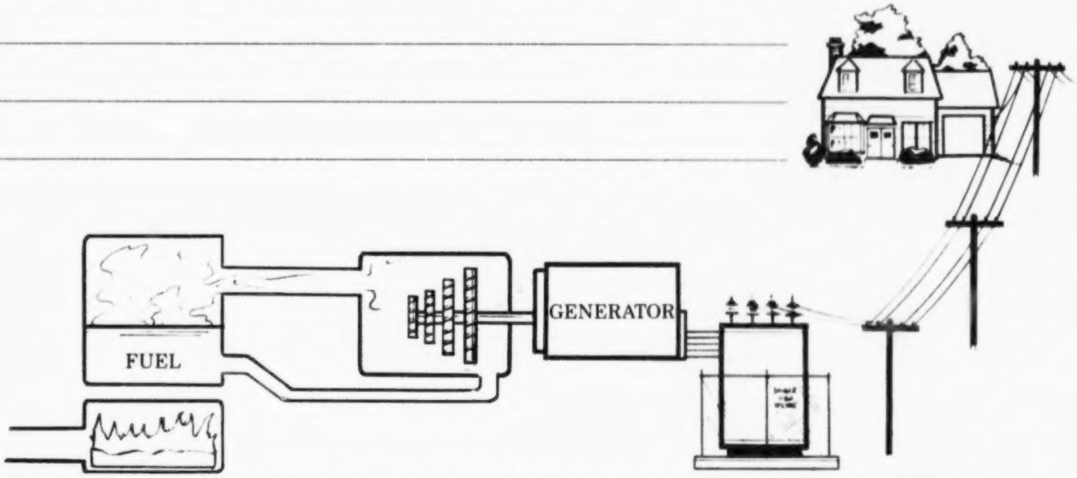
WHY?

1. Why is the burning of fuel important for your life at home? Look at diagram below.



2. What are some fuels that can be burned in a furnace to produce steam?

3. What happens when we burn fuel that can cause harm to the environment? Are some fuels better to burn than others?

4. What do you think can be done when burning fuel to lessen pollution?

5. Why is burning refuse to make electricity called "energy recovery?"

Chapter 5

Recycling and Saving Resources

RECYCLING AND SAVING RESOURCES

CHAPTER 5

Recycling Materials for Manufacturing

The recycling of waste materials has many beneficial environmental effects: it saves energy and resources; it extends the life of our landfills; and it reduces pollution and waste. Recycling is an industrial process involving the use of waste products as sources of raw materials for manufacturing.

There are two types of raw materials: primary and secondary. When virgin resources, such as iron-ore or trees, are used to manufacture products (iron and paper), these raw materials are called ***primary materials***. When recycled products are used in manufacturing as raw materials, they are called ***secondary materials***. When recycled materials are used in manufacturing processes, both virgin resources and energy are saved.

Saving Energy

The largest industrial consumers of energy in the United States are industries that produce primary materials such as iron, steel, aluminum, copper, paper, plastic and glass from virgin resources. These industries use more energy than industries that make final consumer products such as food cans, beverage containers and newspapers from steel, sheet aluminum and newsprint. Therefore, using secondary (recycled) materials in the making of glass bottles, aluminum cans, newspapers and the like circumvents some of the most energy intensive steps in the making of a product.[1]

For example, the production of steel from recycled ferrous metal saves the energy used in mining iron ore, coal and limestone, which are the raw materials required for the production of virgin steel. The energy required to produce a pound of virgin rubber is 15,700 BTU's, while production of an equivalent amount of rubber from recycled rubber requires 4,600 BTU's. This represents a savings of 70 percent. Thousands of kilowatt-hours of electricity are needed to make each ton of aluminum from bauxite, while using recycled aluminum requires only two to four percent as much electricity, representing more than a 95 percent savings in energy.

Other household recyclable materials such as newspapers, glass bottles and jars, and plastic bottles also reduce energy consumption when used as secondary materials in manufacturing processes. Paper made from recycled paper instead of virgin wood pulp requires 64 percent less energy to make. Making glass from recycled glass saves the energy required to fuse the primary raw materials used to make glass: sand, soda ash and limestone. Recycling plastic bottles into new products saves from 50 to 60 percent of the energy that would be required to make the same products from virgin material.

As recycling saves energy it also saves nonrenewable natural resources in the form of fossil fuels used to produce energy. ***Fossil fuels*** are primarily oil, gas and coal. Use of fossil fuels in industrialized countries accounts for about 90 percent of global commercial energy requirements.[2]

Saving Resources

Not only is energy saved by recycling, but valuable natural resources, used in the manufacturing of products, are saved. For each ton of scrap used in making new iron and steel, one and one-half tons of ore are saved. One gallon of waste oil can be recycled to make two and a half quarts of recycled motor oil, while it takes 42 gallons of high quality crude oil to produce the same amount. The recycling of aluminum saves bauxite ore and the recycling of synthetic rubber and plastics saves petroleum. When paper and glass are recycled energy savings are perhaps more important than direct natural resource savings. This is because sand used to make glass is in plentiful domestic supply and wood pulp used in making paper comes from trees, a renewable resource.

What is most important about recycling is that it saves ***nonrenewable resources*** in two ways. It saves nonrenewable resources such as bauxite, iron-ore and petroleum that are used to make materials, and it saves nonrenewable fossil fuels used to provide energy to process these materials.

Per capita, the United States and Canada are the biggest consumers of energy and resources. Just how many world resources are consumed by people in the U.S. is highlighted by the fact that the United States has 6 percent of the world's population and uses between 40 and 50 percent of the world's nonrenewable natural resources. Most countries in the world, because of economic and technological limitations, cannot afford to consume the large amounts of nonrenewable resources that developed countries use. (Most people in the world depend more on wood than any other single energy source for their daily energy needs.[3]) Yet, as nations continue to develop, they will increase their consumption of nonrenewable resources to run machines and to manufacture products. This creates more competition for resources that become more scarce. In fact, many higher grade ores are becoming difficult to find because of their use in large quantities to meet world demand for manufacturing products. As more nations compete for existing resources, conflicts will no doubt increase, which will require an environmental ethic to protect both people and resources from being exploited.

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[1] Energy savings in the production of a manufactured good from recycled materials is figured by adding all energy inputs, including the processing and transportation of fuels and raw materials, mining costs, heat and light for operating facilities, etc., and subtracting from this figure the energy required to recycle used materials to produce the same unit of basic materials.

[2] *World Resources 1986*: A Report by the World Resources Institute and International Institute for Environment and Development, (New York: Basic Books, Inc., 1986), p. 103.

Saving the Environment

The potential benefits of recycling extend beyond saving nonrenewable resources and energy costs. Recycling also reduces pollution and waste. Much of the world's pollution and waste comes from the refining and production of primary materials which are circumvented by recycling. For example, using ferrous metal scrap from recycled automobiles, appliances and food containers instead of iron ore to make new steel products means an 86 percent reduction in air pollution, a 76 percent reduction in water pollution, a 97 percent reduction in mining waste and a 105 percent reduction in consumer wastes that might otherwise go to a landfill.[4] Regarding the processing of aluminum, large quantities of mineral wastes are generated when making aluminum from bauxite, while making aluminum from aluminum scrap produces almost no waste. Pollution and waste from extracting and refining operations is increasing because more lower grade ores are being used in production due to the scarcity of higher grades. Recycling as a method of resource recovery will increase in importance given the scarcity of easy-to-refine materials.

Saving Resources by Burning Waste

Recycling waste materials is not the only way to save resources. Another way to use waste is to recover energy directly from it. This is done through ***energy recovery systems*** that burn waste to produce steam or electricity or a combination of both. When combustible waste is burned to produce steam from a boiler, 2.5 to 3 pounds of steam is generated per pound of waste.[5] Boilers heated by burning waste can also provide input to a steam turbine for the generation of electricity. About 400 to 500 kilowatts are generated per hour per ton of solid waste.[6]

Sometimes instead of burning waste directly, a type of fuel called refuse derived fuel (RDF) can be made from waste and burned in boilers especially constructed for RDF. RDF can also be burned as a fuel supplement with coal. RDF is usually made from paper, light plastics and yard waste. Plastic has a very high BTU value, about 12,000 to 20,000 BTU's per pound as compared to wood at 9,000 BTU's and raw municipal solid waste at 5,000 BTU's.

Energy recovery, like recycling, conserves natural resources. When used as a fuel supplement, solid waste can help save resources used in the production of energy. If all materials and potential fuels in municipal solid waste could be recovered and recycled, it is estimated that about 2.6 percent of the nation's energy use could be met or avoided.[7] To this must be added the conservation of landfill space when waste is burned rather than buried and the worldwide conservation of nonrenewable resources.

The Incineration Controversy

Any time materials are burned, chemical changes result in the creation of ash and gases which can pollute the environment. Some materials when burned create especially harmful substances. For example, ***dioxin*** is produced from the combustion of materials containing chlorine compounds. These materials include plastics, table salt and bleached paper. Some types of dioxins are among the most toxic molecules known, capable of weakening the human immune system and affecting fetal development.[8] Other toxic agents produced by burning solid waste include acid gases such as hydrogen chloride and hydrogen fluoride and contributors to acid rain such as sulfur dioxide and nitrogen oxides. These potentially toxic substances are often found in air emissions.[9]

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[3] Ibid.

[4] *Mines Above Ground*, Institute of Scrap Iron and Steel (Washington D.C.).

[5] Calvin R. Brunner, "Small-Scale Resource Recovery: An Overview" *Waste Age*, (November, 1985), pp. 57-60.

[6] Ibid.

[7] Christopher Hill and Charles Overby, "Improving Energy Productivity Through Recovery and Reuse of Wastes," *Energy Conservation And Public Policy*, ed. John Sawhill (Prentice Hall, 1979), p. 175.

Incinerators' ash residues consist of ***fly ash*** and ***bottom ash***. Bottom ash is heavier and is collected at furnace grate level. Lighter fly ash floats in furnace heat and is collected at a higher point. Both are quenched in water and landfilled. Fly ash often contains toxic metals, including lithium, cadmium, mercury, lead, chromium, copper and nickel. The toxic metals come primarily from batteries in solid waste, and are a potential source of groundwater pollution. Their concentration in incinerator ash must be monitored and minimized. Landfills in which incinerator ash is placed must be securely lined and not sited over aquifiers.

Modern incinerators and refuse-to-energy plants can be constructed and operated so that harmful emissions and residues are reduced considerably. Some measures that can be taken include use of state-of-the-art furnaces and flue gas controls such as scrubbers and electrostatic precipitators, and preliminary separation of waste materials that result in potentially harmful substances when burned.

Exactly what measures should be taken to prevent pollution by waste incineration is uncertain for no nationwide emission standards have been established for waste-to-energy plants in the United States, nor are there federal guidelines on permissible dioxin levels.[10] Sweden, where half of all trash is burned, is one of the few countries to have established strict dioxin emission standards. By Swedish standards only one of the 70 operating resource recovery plants in the United States approaches safe operation for the environment.[11]

Another uncertainty is that we do not know how much dioxin in the air is contributed by waste burning facilities. Other suspected sources include automotive exhaust, pentachlorophenal preservatives and industrial emissions.[12] Considering that the same amount of dioxin is found in human tissues of people living in rural areas as is found in the tissues of people living in urban areas where refuse incinerators are usually located, automotive exhaust can be theorized to be the greater source of dioxins.[13]

There are so many uncertainties about how dioxin forms and how it can be eliminated that it is wise to proceed with caution. However, the design and construction of refuse-to-energy facilities is increasing in the United States as a quick, albeit expensive, fix is sought for the refuse problems of large cities.[14]

In the near future, or until we know more about the pollution problems created by burning waste, a sensible approach to waste problems appears to be the implementation of ways to reduce the amount of waste requiring disposal, with particular emphasis on reducing consumption, reusing materials and recycling materials.

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[8] Cynthia Pollock, *Mining Urban Wastes: The Potential For Recycling*, Worldwatch Paper 76 (Worldwatch Institute, 1987), p. 18.

[9] "A Burning Question: What To Do With Garbage," *transAtlantic PERSPECTIVES* 16 (Autumn, 1987), p. 6.

[10] Cynthia Pollock, *Mining Urban Wastes*, ibid., p. 19.

[11] "A Burning Question: What To Do With Garbage," *transAtlantic PERSPECTIVES*, ibid, p. 3

[12] Carolyn S. Konheim, "Conference report . . .," *Waste Age* 17 (November, 1986), p. 76.

[13] Carolyn S. Konheim, "Dioxin Exposure and Motor Vehicle Emissions," *Waste Age* 17 (November, 1986), p. 70.

[14] In 1987 *Waste Age* compiled a list of 350 waste-to-energy facilities and plants in the United States, including refuse-to-energy plants which have been operational for 10 years as well as those in the early planning stages. "The Waste Age Refuse-to-Energy Guide," *Waste Age* 17 (November, 1986), p. 197.

THE ORIGINAL SOURCE

CHAPTER **5**

ENCYCLOPEDIA

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *classify* waste items by the materials used to make them; (2) identify natural resources used to make processed materials; (3) distinguish renewable from nonrenewable resources used in making materials; (4) *infer* that recycling saves resources. Students will enhance their abilities to *find information* in reference sources and to *cooperate in groups.*

Method

Waste objects are discussed and classified according to the processed materials contained in each one. In groups, students compete to find information about the natural resources used to make processed materials. In a follow-up assignment, students find all the possible resources used to make their favorite object and they explain how recycling saves resources.

Duration: three to four class periods
Setting: classroom and home
Subjects: Science, Language Arts
Curriculum Reference: 2.2

Preparation

Have on hand a variety of consumer items such as bottles, cans, wrappers, bags, rags, paper products, representing the following materials: plastic, glass, tinned steel, aluminum, wood and cloth. (Students could bring in these items from home or you could arrange a cleanup of the school grounds.) Also needed are writing materials and reference sources, especially an encyclopedia; a magnet; several boxes, one labeled "landfill" and the others labeled "plastic," "glass," "ferrous metals," "non-ferrous metals," "wood pulp," and "cloth."

Vocabulary

aluminum, classify, cloth, ferrous metal, glass, metal, natural resource, nonferrous metal, nonrenewable resource, paper, plastic processed materials, renewable resource, steel, tinned steel, wood

Handouts

What Materials? What Sources? Materials and Your Favorite Object

Procedures

1. Place all objects in the box marked "landfill" and explain how they often end up being buried in the ground. Mention that one alternative is to recycle many of these items.
2. Have each student, or several selected students, come up to the "landfill" and pick out one item. Ask them to put it in the appropriate materials box depending on what they think is the material used to make the item. Discuss with students if they do not know the answers. Have a magnet on hand to distinguish tinned steel cans and other steel objects from aluminum. Explain the difference between ferrous metals and nonferrous metals and discuss briefly how processed materials are made from natural resources. (This is as far as you may be able to go with primary students.)
3. Have students divide into groups. Give each group the handout, ***What Materials? What Sources?*** and tell them to complete Part A. Discuss answers. Many answers are possible as items such as bottles and cans can be made from different materials.
4. Have groups compete to complete Part B of the handout. Provide them with as many reference resources as possible. After completing this assignment discuss answers and identify resources on the handout as either renewable or nonrenewable.

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5. Discuss how recycling saves natural resources (requires less energy and fewer natural resources).
6. Ask students to name products that are made from more than one material. For example, bimetal cans (aluminum and steel), gloves (cloth and plastic), toy airplane (plastic and/or wood and/or metal) are among just a few consumer products that are often made of many different materials. Explain how it is harder to recycle products that are made of many different materials because materials must be separated before they can be recycled.
7. Give students the handout, ***Materials and Your Favorite Object***. Have them complete Part A at home and bring the handout back to class. Discuss their choice of object: why it is their favorite thing and what materials were used to make it. See which student has listed the most materials. Then have students complete Part B of the handout using reference sources.
8. Explore the following questions with students.
    - What had to be done to the natural resource(s) before it (they) became part of your favorite object? (extracted from the earth, cut up, shipped, etc.)
    - How and where was your favorite object made?
    - Where did it go after it was made?
    - Other than natural resources used to make materials in your object, what other natural resources may have been used in the production and distribution of your favorite object? (energy costs to produce materials, to make the object, and to transport it to market, etc.)

Evaluation Make cards with product names on them: "glass bottle," "aluminum can," "plastic cup," etc. Have each student pick a card and tell orally or in writing what natural resources were used to make the product, including resources for energy and transportation.

Directions: **PART A** Classify each item from the "I
terial used to make the item. **PART B** Find and list
in Part A.

ITEMS: Soda bottle, pop can, sock, nail, magazine
candy wrapper, syrup bottle, paper plate,
pan, soup can, door knob.

	WOOD (PULP)	GLASS	PLASTIC
PART A			
			NATURAL
PART B			

TEMS" list below by writing it in the box beneath the ma-
the natural resource(s) used to make each material listed

e, 6-pack ring holder, rag, napkin, beer can, mustard jar,
foil, window, cardboard box, tent stake, pie pan, cooking

	ALUMINUM	TINNED STEEL (STEEL)	CLOTH

L RESOURCES

MATERIALS AND YOUR FAVORITE OBJECT?

1. What is your favorite object? It could be a toy, tool, machine or other object you are fond of. Observe the object closely. Draw a picture of it in the box, and beginning from areas outside the box draw an arrow to each part of the object. At the beginning of each arrow write the name of the material from which each part was made.

2. List all of the materials used to make your favorite object and find out what natural resource was used to make each material. (Use encyclopedia and/or handout completed in class.)

MATERIALS	NATURAL RESOURCE

(Continue on back of page if you have more materials and resources to list.)

RESOURCES IN THE LIFE OF A NEWSPAPER

CHAPTER **5**

SAVE
ENERGY
AND
RESOURCES
RECYCLE

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *describe* the energy and resources required to make newspaper; (2) *identify* energy and resources that are conserved when newspaper is recycled. Students will improve their abilities to *infer* and to *make deductions.*

Method

Students list energy and resources used in the making of paper by observing a diagram of the paper making process. They identify further energy and resource requirements in the *life* of a newspaper by listening to more information. They suggest alternatives to ending the life of a newspaper.

Duration: three to four class periods

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 2.1, 2.2

Preparation

writing materials and encyclopedias

Vocabulary

energy, process, natural resources

Handouts

Energy and Resources in Newspaper Making; Making Paper; Sequencing the Life of a Newspaper; and a reading story, ***Printing and Delivering a Newspaper***

Procedures

1. Explain how natural resources, electricity and fuel are needed to make products: to provide raw materials, to run machines, to make machines,to heat factories, to deliver products, etc.
2. Have students complete the handout, ***Energy and Resources in Newspaper Making,*** using the diagram handout, ***Making Paper***. Note that there are many possible answers depending upon what students infer. Most of the stages of the process can be traced back to the sun's energy. You may want to distinguish renewable from nonrenewable resources the students mention (e.g. sun and trees are renewable, oil and iron ore are nonrenewable). Also, there may be other considerations not depicted in the diagram (e.g. electricity to heat the mill and to run lights to see the machines), which may be listed by perceptive students.
3. Have students deduce what types of energy and resources are saved by recycling newspaper. Making paper from recycled paper begins at the pulping stage ("D" on the diagram), where water and chemicals remove ink and turn paper into pulp again.
4. Continue the discussion of resource requirements by reading the story, ***Printing and Delivering a Newspaper***. Have students identify, based on your reading of the story, what additional energy and resources are used in a newspaper's *life*. Students should be able to suggest a final stage of a newspaper's life other than the trash can or landfill (i.e. recycling). See if students also mention reuse possibilities such as papier-mache and fireplace logs.
5. If possible, begin a paper recycling drive at your school.

Evaluation

1. Give each student the handout, ***Sequencing the Life of a Newspaper***, to complete.
2. Have students use encyclopedias to look up processes for making aluminum, glass and/or plastic and have them identify resources and energy used to make these materials.

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ENERGY AND RESOURCES IN NEWSPAPER MAKING

Directions: Identify as many types of energy and resources as you can that are used to make newsprint and to ship it to the newspaper printer. To do this, look at the stages of paper making shown on the handout, ***Making Paper***. Match each paper making stage (A-G) with one or more of the three resources listed below. Put the letter of the paper making stage in the answer space and explain what type of resource is used in that stage. (See examples already written in Parts 2 and 3 below.) Remember, each stage of paper making (A-G) on the diagram may be used more than once in more than one of the three categories listed below.

1. Light energy from the sun:

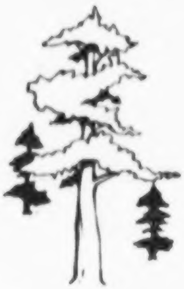
2. Natural materials (including iron ores, plants, coal, gasoline and oil):

B, saw is made of steel from iron ore.

3. Energy: E, need electricity to run motors that turn rollers

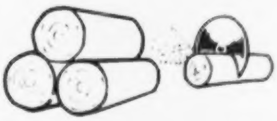
MAKING PAPER

A



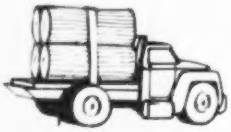
Trees grow in the forest.

B



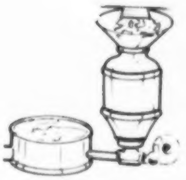
Trees are cut with a saw into logs.

C



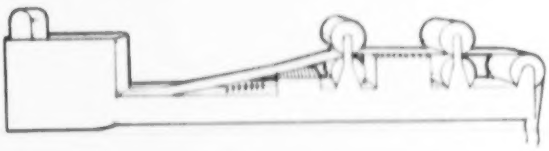
Truck hauls the logs to the mill.

D



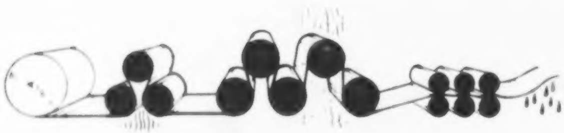
After logs are cut into chips they are mixed with chemicals and cooked into a mushy pulp.

E



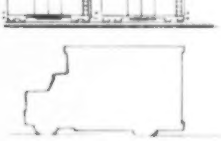
The pulp goes through machines that rub and press and screen the pulp into wet sheets of paper.

F



Steam-heated rollers dry the wet sheets of paper and they are wound into large rolls.

G



Trucks or trains take the rolls of paper to a printing press where a newspaper is made.

SEQUENCING THE LIFE OF A NEWSPAPER

Directions: Put these events in order from "1" to "9". Number "1" should be the first event. There are two possible answers for number "9." Put a "9" by the best answer and leave the other blank. In the space at the bottom of the page tell why your answer to number "9" is the best.

______ A chipper cuts the logs into little wood chips.

______ Some people put their newspaper in the trash when they finish reading it.

______ Trees are cut and sawed into logs.

______ Delivery trucks take the newspapers to neighborhoods and papergirls or paperboys deliver them.

______ Newsprint is put on a printing press and printing begins.

______ Some people save their newspaper for recycling when they finish reading it.

______ Light energy from the sun is stored in trees.

______ Wood chips are cooked until they become pulp.

______ Cut logs are transported to the paper mill.

______ Steam-heated rollers dry the pulp as it is pressed into paper sheets.

Before a newspaper is printed, reporters, writers, photographers, artists and other news staff members work hard to gather the news. There are also workers who set the type and who arrange the stories, pictures and ads on each page. Then more people make the printing plates which will print the words and pictures. Now the newspaper is ready to be printed.

The printing plates, which print the news in black or colored ink on the newspaper, are locked in the printing press. The paper is put through the press and the printing begins.

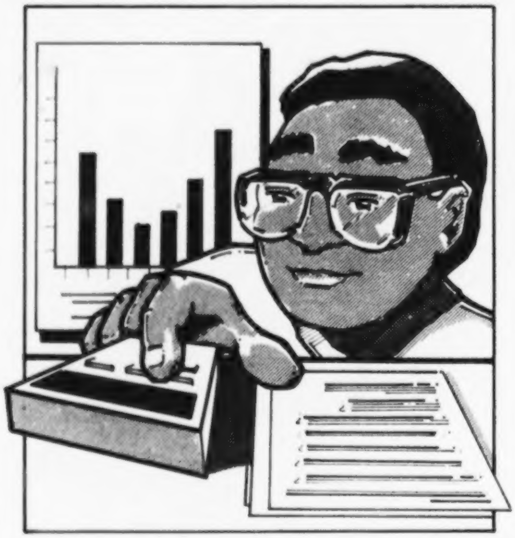
After the printing is finished, part of the printing press cuts the paper into sheets and folds it into pages.

The newspapers are then taken by conveyor belt to the mailroom where they are bundled and sent to the loading dock.

Delivery trucks are loaded with the newspapers. They take the papers to neighborhoods throughout the city. Paperboys or papergirls deliver the newspapers to people's houses.

HOW MUCH DO WE USE?

CHAPTER 5



INTERMEDIATE

Objectives Students will be able to: (1) *observe* and identify quantities of paper used at school; (2) *infer* the consequences of using trees to make products. Students will improve their abilities to *organize data* and *compute figures*.

Method Students record on a chart how much paper is used during a week and then *make a graph* using this information. They identify changes in behavior based on information about how much paper is used and wasted. They answer questions about conservation and resources based on comprehension of a reading passage.

Duration: four class periods over two weeks

Setting: classroom

Subjects: Social Studies, Mathematics, Language Arts

Curriculum Reference: 2.2, 6.1

Preparation Identify what types of paper are used weekly in the classroom, such as writing paper, paper towels, construction paper, ditto paper and drawing paper. Use chart paper and graph paper to record this information.

Vocabulary calculate, conserve, graph, natural resource, renewable

Handouts ***Webbing Products Made From Trees; Calculating Resource Use***

Procedures

1. For one week tally the amount (in sheets) of the different types of paper consumed by the class. Each student could make his or her own chart and total up all figures on a classroom chart at the end of each day. The chart could be made as follows:

PAPER CONSUMPTION IN OUR CLASS

Make a tally mark under the correct heading and next to the correct day each time you use paper this week.

	Type of Paper					
Day	Photocopy or Ditto	Workbook Page	Writing Paper	Construction Paper	Paper Towel	Kleenex
Mon.						
Tues.						
Wed.						
Thurs.						
Fri.						

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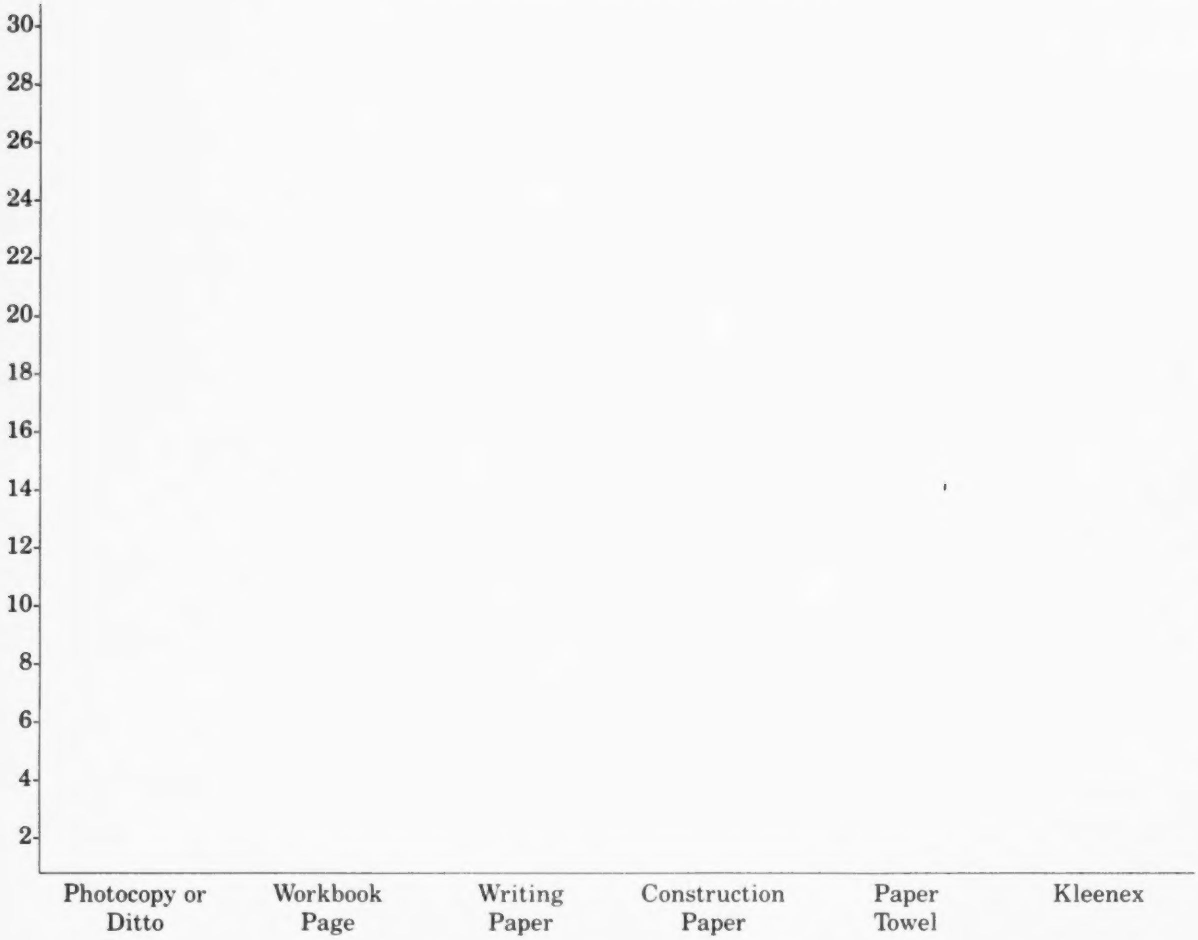
2. At the end of the week, construct a bar graph using this data. The bar graph could be made using graph paper as follows:



PAPER USED THIS WEEK IN OUR CLASS

3. Discuss the figures. Are students surprised? Have students make calculations. Ask them how they can calculate the average amount of each type of paper used per pupil each week. (Divide the number of sheets in each category by the number of students.) Ask students how they can find how much paper of each type they use in a year, individually and as a class. (Multiply by the number of school weeks.) What type of paper is used the most? Why?

4. The following week, monitor or have students collect data regarding how much paper they use. At the end of the week, discuss their feelings. Had they changed their habits any because of the previous week's findings on paper consumption? Did this make them try to be more conserving? What if someday we didn't have the supply of trees needed to fill the demand for paper? Have students suggest reasons why we might use up all the trees needed to make paper (e.g. increased consumption of wood and paper products, cultivating more forest areas for food crops, poor planning to renew forest trees).

5. What other things besides paper are made from trees? Use the handout, ***Webbing Products***

Made From Trees, for this purpose. Then, looking at their answers, have students suggest ways they could help conserve trees. (Use both sides of paper, cut down on tissues and paper towels often wasted, refinish old furniture, etc.)

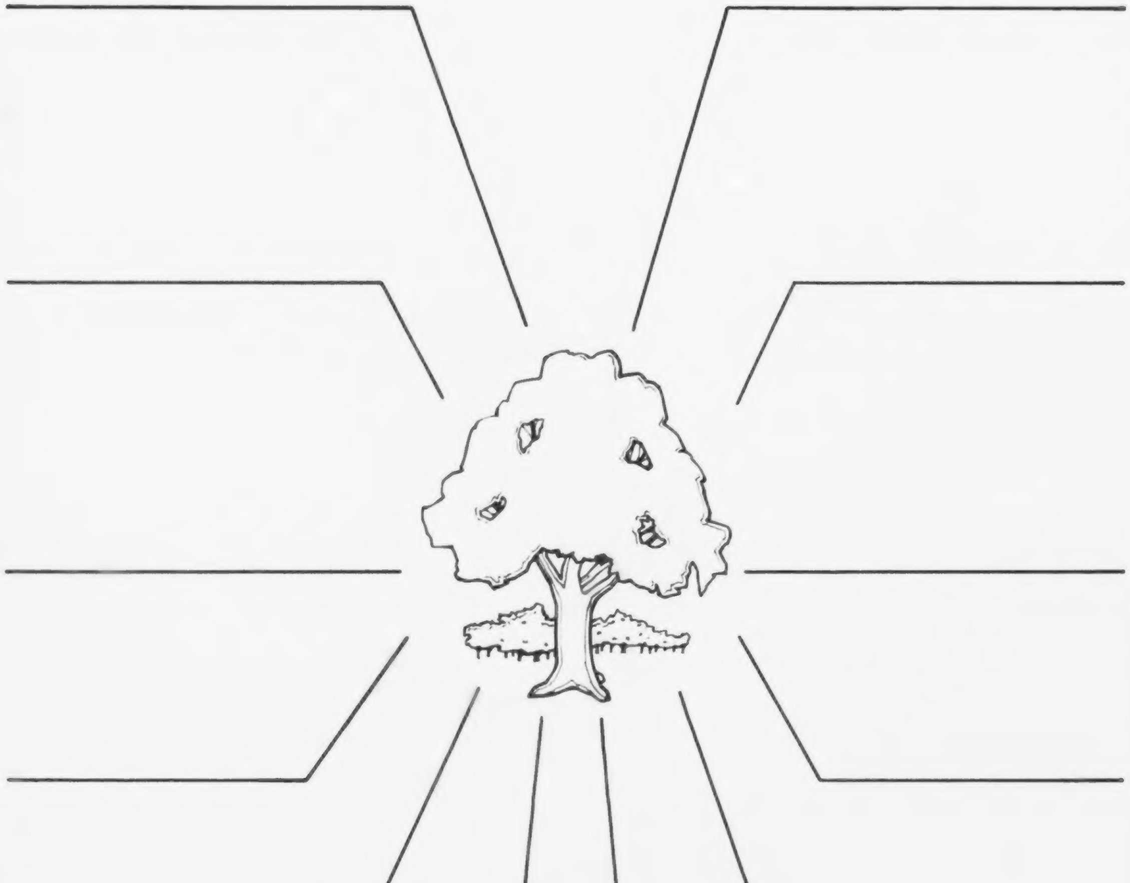
6. Introduce the word recycle and explain how paper can be recycled to conserve energy and resources.
7. Have students complete the handout, ***Calculating Resource Use***, and discuss.

Evaluation

Have students write a paragraph or draw a picture showing how we can help to conserve paper.

WEBBING PRODUCTS MADE FROM TREES

Directions: Think of as many products as you can that come from the natural resource-trees. "Web" your ideas around the tree. Draw more lines if you need to.



CALCULATING RESOURCE USE

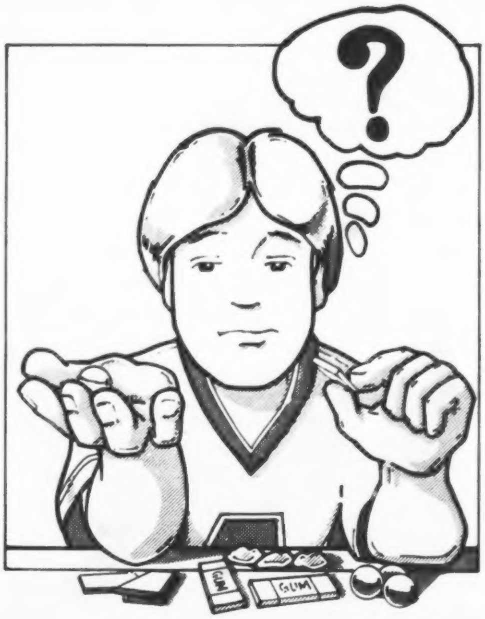
Directions: Read the passage below and answer the questions that follow.

Trees are a renewable natural resource. They are renewable because they can be grown as other trees are cut down. However, there is much demand for products such as paper, cardboard and furniture which are made from trees. Trees are also cut down to clear land for building houses and farming crops. Therefore, trees need to be planted constantly and people should not waste products made from trees. One way to conserve trees is to use paper and paper products over again or to recycle paper.

Many trees are cut down and new ones replanted each year to make newspapers. It is estimated that one 17′ tree is required to make 118 lbs. of newsprint for making newspaper. For every 4′ stack of newsprint produced, a 17′ pine tree is used.

1. In the first sentence:
   a. Which word means the opposite of human-made? ________________
   b. Which word means something can be made again? ________________
   c. Which word means something we use to make a product? ________________
2. How many pounds of newsprint can be made from one 17′ tree? ________________
3. If one week of newspapers (seven papers) is 3 inches tall, how many newspapers are in a pile one foot tall? ________ in a pile 4′ tall? ________
4. How many newspapers can be made from a 17′ tree?
5. About how many pounds of newsprint are required to make an average newspaper? ________
6. Based on the answer to #7, approximately how many pounds of newspaper does a family generate in one week? ________ in one year? ________
7. Approximately how many 17′ trees are required to make a year's supply of newspaper for one family (receiving 7 papers a week)? ________ for all the families in your classroom for one year? ________

RESOURCES SIMULATION



PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *identify* natural resources used in packaging materials and whether these resources are renewable or nonrenewable; (2) *explain* why many natural resources we use to make products must be imported from other countries. Students will improve their ability to *analyze information*.

Method

A simulation activity is conducted in the classroom using marbles and chewing gum. Students *make analogies* between the simulation activity and the use of natural resources to make consumer products.

Duration: one or two class periods following the simulation activity conducted during the morning and early afternoon

Setting: classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 2.2, 6.5

Preparation

marbles — a few less than the number of students; 30 sticks of sugarless gum prepared in the following manner:
10 pieces as they come from the package, wrapped in foil and paper;
10 pieces of gum just in the foil (paper wrapper saved);
10 pieces of gum, foil removed and saved and gum put back in the paper wrapper;
10 pieces of foil; 10 paper wrappers; extra paper wrappers saved ahead of time.

Before the children come to school the day of this activity, hide the marbles and the different pieces of gum and wrappers as described below:

- The marbles — on their desks; some desks may have 2-4, some only 1, some none.
- Hide all the pieces of gum (those pieces in foil or in paper or in both) in their desks, on desk chairs or on top of desks. Hide some of the paper wrappers in these places as well.
- Hide the pieces of foil and the other paper wrappers around the room (not in or on their desks or chairs). Make some visible but hard to reach and some impossible to get to.

Vocabulary

analogy, export, import, natural resources, nonrenewable, packaging, renewable, simulation

Procedures

1. This is a simulation activity after which comparisons will be made by students. As the children come into the room this day and notice the various objects, feign ignorance about them. When they ask about taking them, again pretend you don't know anything about them. At any break, when children might be out of the room (lunch, recess) put more paper wrappers, only, out in the room. (These are the extra ones saved in addition to the 30 sticks.)

2. At the end of the day, ask the children to get out any foil, paper gum wrappers, gum or marbles they have. Count and record on chart paper. Check the floor for any—record these under "Littered." Check the waste basket—record these under "Thrown Away." Record any chewed pieces of gum found under "Garbage." If there are still some left, have students hunt for them. Discuss the chart and the meaning of litter, throw-away packaging and garbage. Note that when we throw away marbles and paper

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and foil, we are wasting natural resources, those raw materials used to make glass, paper and foil.

3. Write the listings below on the board.

marbles
foil
paper
foil wrapped gum
paper wrapped gum

paper products (including cardboard)
products packaged in paper
aluminum products
products packaged in foil or aluminum
glass products

Ask students to match the item in the left column with the item in the right column that it represented in the simulation. After doing this, ask students to list as many paper products as they can; as many aluminum products as they can; same with glass; also discuss packaging made of paper, aluminum or glass.

4. Discuss what paper, glass and aluminum are made from: trees, sand, bauxite. So the paper wrappers also represented trees, the marbles sand and the foil bauxite.

5. Draw the attention of students back to the simulation activity, asking them where various items were found. Write the following answers on the board as students give them to you:

   a. marbles found in and on desks,

   b. foil wrappers without gum found around the room,

   c. paper wrappers without gum found in and on desks and around the room,

   d. foil wrapped gum and paper wrapped gum found in and on desks.

   Ask students what each of these placements means if their desks represented the United States and if places in the room other than their desks represented other countries in the world. Go over each lettered item above one at a time. Answers corresponding with these letters are below:

   a. Natural resources used to make glass, in particular sand (the marbles), is found in abundance in the U.S.

   b. The natural resource, bauxite, is usually imported (sent to the U.S.) from other countries such as Guinea, Australia, Brazil and Jamaica. (Some bauxite is found in the U.S. in Texas and Arkansas.)

   c. The natural resource used to make paper — trees — is found in the U.S. But the U.S. also imports wood from Canada.

   d. Americans make many packaging materials for their products. Many countries in the world seldom use packaging or do not use as much as we do.

   Ask students if there could be a way to reduce the packaging of gum and what the purposes of packaging are. (preservation, advertisement)

6. Ask students why there were more marbles than any other single item. (Sand is abundant, but it is nonrenewable.) Why were additional paper wrappers put out? Trees are a renewable resource; they can be planted to make more trees. Why was there less foil than any other item and why was no new foil put out? There is less bauxite than sand or trees in the world and bauxite is a nonrenewable resource. Ask students who found a stick of gum with both foil and paper wrapper where these were found and what they represent. (Some products, in the U.S., are packaged with both aluminum and paper—e.g. TV dinner in a box.) Ask if anyone littered the paper after taking the gum out.

7. Discuss what factors affected who got which resources—who got to school first, where the resources were, aggressiveness in finding resources, how hidden they were. Compare this to real countries. It is easier for a country to obtain a resource found within its own boundaries. What does a country do if it needs a resource that is not found in the country, or if it doesn't have enough? (Import)

8. Discuss the importance of recycling as a way to save resources and reduce imports. Mention that in most areas of Ohio glass, aluminum and newspapers can be recycled.

Evaluation

Have students write about the activity—what they felt while participating in it (unknowingly) and what they learned, including what the marbles and each part of the gum and wrappings symbolized.

WHEN THEY'RE GONE, THEY'RE GONE

CHAPTER **5**

SAVE EARTH'S RESOURCES

INTERMEDIATE

Objectives

Students will be able to: (1) distinguish nonrenewable natural resources from renewable natural resources; (2) identify the consequence of burying waste and *suggest alternatives* that save nonrenewable resources; (3) *explain* the uneven distribution of natural resources among countries of the world. Students will improve their abilities to *make inferences* and *classify*.

Method

Students answer questions about natural resources and solid waste in a pre-test. They take part in a simulation activity about the distribution of finite resources around the world. They discuss how the simulation activity represents international competition for resources. Students take the post-test and discuss alternatives to throwing away resources.

Duration: two to four class periods

Setting: classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 2.2, 6.5

Preparation

craft beads: 400 red, 104 blue, 31 pink, 12 green, 1 orange, 1 yellow, 1 purple, 1 clear; 6 plastic cups; writing materials

Vocabulary

conservation, industrialization, landfill, natural resources, nonrenewable resources, recycling, renewable resources, scarce, solid waste

Handout

Wasting Waste (used as a pre- and post-test)

Procedures

1. Discuss the following statement with the class: As countries become more industrialized and developed they consume more natural resources. Give students the pre-test telling them you want to see what they already may know about natural resources and waste.
2. After collecting the handout, explain to students the difference between renewable and nonrenewable natural resources; make a list on the board. Then proceed to explain the activity. Beads of different colors have been selected to represent nonrenewable resources. The number of beads reflect a mineral's relative estimated total abundance, not that mineral's ease of extraction or potential availability.

Color	Beads	Finite Resource	1987 Estimates of Global Reserves[1]
Red	400	Iron in Ore	98.0 Billion Short Tons*
Blue	104	Bauxite (aluminum ore)	23.2 Billion Metric Tons**
Pink	31	Chromium	7.5 Billion Short Tons
Green	12	Copper	566.0 Million Metric Tons
Orange	1	Lead	142.0 Million Metric Tons
Yellow	1	Tin	4.3 Million Metric Tons
Purple	1	Silver	10.8 Billion Troy Ounces
Clear	1	Platinum	2.1 Billion Troy Ounces

* Short Ton = 2,000 pounds ** Metric Ton = 2,200 pounds

1988 Ohio Department of Natural Resources; source: Diana Rogers, Columbus Clean Community (Columbus, Oh)

[1] Source: U.S. Bureau of Mines, *1987 Mineral Commodities*. U.S. Deptartment of the Interior, Avondale, Maryland.

3. You might want to reproduce the first three columns of the chart on the board. Tell students that these beads will be used in an activity later in the day.
4. Hide beads throughout the classroom when students are out (some in easy to find places and others in more difficult places to find).
5. Have students divide into teams representing countries. To show increased potential in exploring for resources, vary the size of each group (USA 6, USSR 6, Europe 4, Japan 3, South Africa 2, Malaysia 1, etc.).
6. Give teams time to explore for resources. First, give them two minutes to search around the room and then return to their group. Have them collect beads in the plastic cups. Repeat search again, but this time for only one minute. After each exploration, students should separate and consider results based on beads they have accumulated in their cups. These can be compared with the relative figures on the chart.
7. Discuss the greater difficulty in finding resources during the second period of exploration. (Competition becomes more intense for fewer resources.) Discuss real life examples of countries competing for resources.
8. Beads in the plastic cups represent natural resources which are eventually thrown away in the form of products which people discard. Some natural resources are used for many years, sometimes hundreds of years, while other natural resources are used for a very short time only and end up in landfills. Ask students how this happens. Discuss the future mining of landfills for natural resources.
9. Ask students what they can do to extend the life of nonrenewable resources? (recycle) What are the advantages of extending the life of resources? (More resources available in the future, lessening of international conflict, etc.)

Evaluation

1. Have students complete the post-test.
2. The following day or later, have students answer the following:
   a. Did you use a product made from a renewable resource today? If yes, what?
   b. Did you use a product made from a nonrenewable resource today? If yes, what?
   c. What can you do today to help conserve natural resources?

WASTING WASTE:
A PRE AND POST TEST

Directions: Answer the questions below by putting the letter of the one best answer in the blank.

1. An example of a renewable natural resource is a ________.

   a. metal b. fossil fuel c. plant

2. A nonrenewable natural resource ________.

   a. can be replaced b. cannot be replaced c. should be wasted.

3. When a product is made, natural resources are ________.

   a. used b. conserved c. increased

4. When we throw away products after they are used most of these items end up ________.

   a. being burned b. in the ocean c. being buried in the ground in a landfill

5. One way to conserve nonrenewable resources is to ________.

   a. reduce the amount of solid waste we produce b. increase the amount of waste we produce c. close down landfills

6. To reduce solid waste, we could buy products that are ________.

   a. used once, then thrown away b. made of plastics c. recyclable

7. Recycling means to ________.

   a. clean up litter b. make new products from old materials c. burn solid waste

8. When we bury trash and garbage in a landfill, we are also burying ________.

   a. new products b. things we should burn c. natural resources

9. Because nonrenewable resources are scarce ________.

   a. countries compete with each other to acquire resources b. every country has all the resources it needs c. countries do not have to trade for resources

TRADING RESOURCES

"NEED A MARKER"
GLUE

PRIMARY/INTERMEDIATE

Objectives

Students will be able to *explain* the economic implications of using scarce resources to make a product. Students will improve their ability to *cooperate in groups.*

Method

Discussion of renewable and nonrenewable resources is followed by a simulation activity to produce a greeting card by requiring the trading of "plentiful" and "scarce" resources among groups. Follow-up discussion requires students to *make analogies.*

Duration: two to three class periods

Setting: classroom

Subjects: Social Studies, Arts and Crafts

Curriculum Reference: 6.3

Special Note: This activity centers on five groups of students representing five different countries with different resources. The materials listed below in the **Preparation** are therefore of five types, each type of material exclusively meant for each group, unless you modify the activity. There are two basic ways to conduct the activity with the five groups. One or both of these versions may be used and there are also modifications to consider based on these two descriptions (see **Preparation** description below). The first version of the activity is planned so that each group has access to the resources needed to make a complete product. The second version is designed so that there are not enough resources for each group to make a completed product. The second version, therefore, creates more confusion and some frustration for students but it is better at replicating issues associated with scarce resources. You may wish to modify the activity so that each group receives multiple resources in quantities reflective of either sufficient resources as in version one or scarce resources as in version two.

Preparation

Version #1: fifty sheets of construction paper, five magic markers, fifty happy-face stickers (try to find some without adhesive backing or use another type of cut-out), five pairs of scissors and five bottles of glue

Version #2: fifty sheets of construction paper, four magic markers, thirty stickers, three pairs of scissors and three bottles of glue

Modification: One group could be given two bottles of glue and thirty sheets of paper, another group two pairs of scissors and twenty sheets of paper, etc.; or you could give each group three different types of supplies, but remember, the more supplies distributed the less "scarce" resources will be.

Vocabulary

analogy, plentiful resources, scarce resources, simulation

Procedures

1. Explain to students the concept of *plentiful* resources (resources for which demand by people does not exceed the supply: generally wood, sunlight, sand, water, etc.) and *scarce* resources for which demand is greater relative to supply, (oil, coal, natural gas). Give examples of how we trade with other countries to acquire resources to make products. Then tell students they are going to engage in a simulation activity.
2. Have students divide into five groups, each assigned to a table representing a country. Distribute materials to each group based on the version you have chosen to use. Show the students a greeting card you want them to reproduce. The card must:
   a. be made with construction paper, folded

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   b. with rounded corners cut by scissors

   c. a happy face sticker glued on the front and

   d. the words "GET WELL SOON!" in marker on the front of the card. Tell class the country that can make the most get well cards will receive a prize.

3. Put a list of rules on the board that students must follow:

   - They cannot borrow at any time.
   - They may trade only once with each table.
   - They may not "trade back."
   - If you cannot acquire all the supplies necessary to make cards as requested, make them however you can.

   Proceed with activity, observing so no one breaks the rules. Mention that a prize will be given to the group that constructs the most cards as requested.

4. Discuss results.

   a. Why couldn't one group produce the entire card alone?

   b. Why did some students have more difficulty trading?

   c. Which resources were plentiful?

   d. Which resources were scarce?

   e. Consider each material: glue, paper, scissors, etc. and discuss which are made from renewable resources (paper and stickers, if the latter are made of paper and not plastic), and which are made of nonrenewable resources (scissors and stickers if stickers are made of plastic or have a plastic coating). The ingredients in glue and magic markers may include both renewable (water, animal parts, dyes) and nonrenewable ingredients (petroleum and metal).

   f. Which item do you think would be the cheapest to buy? Why? Which the most expensive? Why?

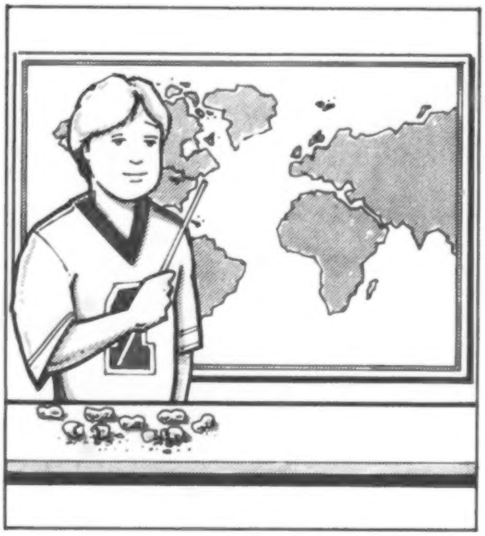
   g. What happens to waste when a country is finished with production? (e.g., scraps of paper, leftover glue, etc. Bring up idea of reuse and recycling to conserve scarce resources.)

5. You may wish to save completed cards to send to students who are ill.

Evaluation Ask students to explain orally or in writing how this activity resembles real life situations. They should include the following words and concepts in their explanations: scarce resources, plentiful resources, trade, country, product.

RESOURCES AND CONFLICTS

CHAPTER 5



PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *identify* natural resources and their distribution around the world; (2) *describe* the general processes of extracting and distributing resources; (3) describe problems created by international demand for resources and suggest possible solutions. Students will improve their abilities to *make inferences* and *solve problems* using information.

Method

Students identify information from maps and pictures to make charts about the distribution and use of natural resources in the world. They take part in a simulation activity after which they describe parallels with the extraction and distribution of natural resources around the world. They *write* a newspaper article about a hypothetical problem between the U.S. and another country.

Duration: three to four class periods

Setting: classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 6.5

Special Note: The handouts in this activity are for intermediate grades and modifications are required to explain concepts to primary grades. However, the simulation and follow-up discussion are appropriate for younger students.

Preparation

world map, if possible one showing the distribution of natural resources; pictures of natural resources and how they are extracted; information indicating providers and users of natural resources in the world; information about what types of products are made from natural resources; pictures from books or encyclopedias of conservation practices in other countries; peanuts in the shell

Vocabulary

distribution, exports, extraction, imports, natural resources, nonrenewable resources, renewable resources, simulation

Handouts

Resource Simulation; In the Press

Procedures

1. Introduce the subject of natural resources in the U.S. and the world. Show pictures of how resources are taken from the earth. Make a chart listing the following nonrenewable natural resources: iron ore, bauxite, copper, tin, petroleum, coal and any others you wish to select that are used to make consumer products familiar to students. Chart the locale of these natural resources by the countries in which they are located. Have students identify which countries have more natural resources than others. Have students infer which countries use more energy and resources.
2. The next day, before students arrive, hide peanuts (in the shell) throughout the classroom: single peanuts and small and large piles of peanuts. Some piles should be easily discoverable and some should be hidden. As the students arrive, make no comments about the peanuts. They will probably begin to collect or even hoard the peanuts. Some may even open the shell and eat them. Later during the day, initiate a class discussion about simulation activities and tell students that you distributed the peanuts to simulate the extraction and distribution of resources around the world. Explain the concepts of extraction and distribution. Have students complete the handout, ***Resource Simulation***, to see how many parallels they can draw between the peanut activity and resource extraction and distribution.

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3. Now draw students' attention back to the chart of U.S. and world resources made earlier in this activity. Discuss the following questions: How might competition for natural resources contribute to international tension? (inflation, need for strategic minerals in case of war, etc.) Explain world interdependence. How do nations conserve nonrenewable natural resources? (People reuse materials; people conserve energy; some countries have little heat and air conditioning technology; some countries use solar, water and wind energy; a variety of recycling and energy recovery programs can be implemented.) Show pictures from books or encyclopedias of these conservation practices in other countries. Ask students what we can do in the U.S. to conserve resources.

4. Have students identify a country that sells natural resources to the U.S. Have them use the handout, ***In the Press***, to write an account of a fictitious international energy and resource conference between the U.S. and that country. Explain what the Secretary of State for the United States does. Suggest the following as possible subjects for student reports.

   - *Item A* on the handout could refer to a shortage, rising cost of a resource creating inflation in the U.S., political changes making shipping of a resource difficult (war, revolution), loans needed for further exploration and extraction of a resource, etc.
   - *Item B* could refer to recycling, conservation practices, change in materials used; but it must relate to the issue stated in passage A.
   - *Item C* could refer to ways the U.S. will meet suggestions made in "B" (e.g., establish a mandatory recycling scheme for products made from the materials in question, set quotas on imports, tax imports, grant a loan, provide economic aid, etc.).
   - *Item D* could refer to further exploration, or quotas, or lower prices, or a way to diversify so the other country's own economy will not be hurt by the shortage, etc.

Evaluation Have students identify three problems associated with the use of natural resources (shortages of nonrenewable resources, pollution, conflicts between countries, inflation) and three ways to save resources (conservation, recycling, reuse, energy recovery, change consumption habits).

RESOURCE SIMULATION

DIRECTIONS: Think about all that happened as you and your classmates discovered the peanuts. For each statement below, describe how it represents the extraction or distribution of natural resources around the world.

1. Some peanuts were hidden while others were easy to discover.

2. Some peanuts were in large piles, others were in small piles, others single.

3. Some students took their peanuts out of the shell.

4. Some students ate the peanuts they took out of the shell.

5. Some students did not open their peanuts nor did they eat them if they did take them out of the shell.

6. Some students found a lot of peanuts, other students found only a few or only one, and some students did not find any peanuts at all.

7. Some students gave their peanuts to others or traded them for something, maybe even other peanuts.

EXTRA: "What if" questions (answer on back).

8. What if some students, after eating their peanuts, went out and planted more peanut plants in a garden? What would this represent?

9. What if peanuts could not be grown and they could only be found in the ground? What would this represent?

CONSERVATION DAILY NEWS

Today, a representative from the country of ____________________

met with the Secretary of State of the United States to discuss ____________

____

A ____________________

____

____

Regarding this issue, the representative from ____________________

suggested that people in the United States ____________________

____

B ____________________

____

____

The Secretary of State of the United States concluded the conference by saying that

the United States would ____________________

____

C ____________________

____

____

The Secretary then suggested that ____________________

____

D ____________________

____

____

The conference ended following the Secretary's comments.

Chapter 6

Waste Out of Place

THIS LITTERED LAND IS YOUR LAND

CHAPTER **6**

SHEET
MUSIC

PRIMARY/INTERMEDIATE

Objectives

Students will be able to *describe* how litter and waste affect the natural beauty of geographical regions in the United States. Students will improve their ability to *write creatively*.

Method

Students *listen* to a recording of "This Land is Your Land" and identify the places mentioned in the song. They *infer* how these places would be spoiled by litter and they construct new lyrics and images for the song. They write new lyrics to other songs of their choice.

Duration: two to four class periods

Setting: classroom

Subjects: Social Studies, Language Arts, Music

Curriculum Reference: 5.2, 5.3

Preparation

Recording of "This Land is Your Land" by Woody Guthrie; tape recorder or record player; litter-free pictures of redwoods or forest, of water forms, of California and New York, of deserts, valleys, countrysides, etc.

Vocabulary

environment, litter, lyric, recycle, region

Handouts

Words and the American Landscape; Litter Known Songs

Procedures

1. Instruct students to listen carefully to words in the recording of "This Land is Your Land."
2. Present pictures as they coincide with the lyrics in the song. Identify geographical regions such as mountain, forest, desert and valley mentioned in the song. Explain how the environments represented by these regions differ in landscape, climate and plant and animal life.
3. Discuss the beauty of the USA when it is free of litter. Discuss how these areas of land would change if littered. Discuss the effects of litter on wildlife, plant life and waterways.
4. Have students complete the handout, ***Words and the American Landscape***.
5. Explain how the subject of litter could lead to changes in the words to the song, "This Land is Your Land." Have students rewrite lyrics and present to class. Illustrate with drawings and pictures. Use the handout, ***Litter Known Songs***, to give students some examples of what you would like them to do.

Evaluation

Have students think of another song they know, (like those which appear on the handout, ***Litter Known Songs***) and write lyrics for it with an anti-litter and/or recycling message.

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6 THIS LITTERED LAND IS YOUR LAND

WORDS AND THE AMERICAN LANDSCAPE

Directions: Think where you would find each word in the dictionary.

Put a:

"**B**" if it is at the beginning. (A-I)
"**M**" if it is at the middle. (J-R)
"**E**" if it is at the end. (S-Z)

1. ______ desert
2. ______ valley
3. ______ forest
4. ______ redwood
5. ______ land
6. ______ pollution
7. ______ California
8. ______ gulf
9. ______ water
10. ______ litter
11. ______ island
12. ______ recycle
13. ______ stream
14. ______ mountain
15. ______ reuse

Look up each of the words above in your dictionary and write out definitions on a separate sheet of paper; then fill in the blanks below.

1. A body of land with water all around it is called an ________________________.
2. Land that has very little or no water is called a ________________________.
3. We should not ________________________ our highways and streams.
4. Oaks, maples and ________________________ are different kinds of trees.
5. Litter on a street or oil in a stream are two kinds of ________________________.
6. A large group of trees is called a ________________________.
7. One way to save natural resources and to keep waste from being littered or thrown away is to ________________________.

To the tune of "Three Blind Mice":

1 Three litter bugs, three litter bugs
2 See how they litter, see how they litter
3 You find them wherever trash is found
They aren't very nice to have around
4 They throw trash and garbage on the ground
three litter bugs

To the tune of "Row Row Row Your Boat":

1 We can use our trash
2 Save it from the can
3 Recycle! Recycle! Recycle! Recycle!
4 That's our final plan

To the tune of "Friar Jacques":

1 Please don't litter, Please recycle
2 Glass and tin, aluminum
3 Paper, cardboard, plastic, once again's fantastic
4 Recycle, Recycle

To the tune of "Beer Barrel Polka":

1 Roll out the barrel
2 We have a barrel to fill.
3 Roll out the barrel
4 There's litter all over the hill.

5 Stop, pick the litter,
6 We want the people to know,
7 When they come to visit - here
8 Leave a clean O-H-I-O.

9 Roll back the barrel,
10 We've got it filled to the top.
11 Roll back the barrel,
12 In went the trash with a plop.

13 Stop, pick up the litter,
14 We want the people to know,
15 When they come to visit - here
16 Leave a clean O-H-I-O.

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WASTE AND WORDS

CHAPTER **6**

INTERMEDIATE

Objectives

Students will be able to: (1) *describe* litter in a particular setting and (2) *explain* the effects of litter on aesthetic sensibilities. Students will improve their abilities to *observe* and *write creatively*.

Method

Students identify synonyms for waste and write sentences describing their feelings about litter. They observe litter in their environment and describe where it is located. They use this information to write descriptive words for alliterations and to make pictures for their alliterations.

Duration: three to four class periods

Setting: classroom, neighborhood

Subject: Social Studies, Language Arts, Art

Curriculum Reference: 5.3

Preparation

Four index cards for each student, suitable littered area, paper and crayons or paints for making pictures.

Vocabulary

alliteration, environment, litter, recycle, synonym

Handouts

Feelings About Waste; A-litter-ation Litter; Lost In Litter

Procedures

1. Have students list as many synonyms (words that mean the same or almost the same thing) as they can for the word "waste." Examples: litter, trash, garbage, refuse, rubbish, scrap. These terms are explained in the Background Information to Chapter One.

2. Have the students list as many waste items as possible. Examples: wrappers, bottles, cans, paper.

3. Give students the handout, ***Feelings About Waste***, to complete.

4. Have students hunt in an assigned area to find pieces of litter (you could designate areas in their neighborhood and make this a homework assignment). Each student jots down the name of the litter, e.g., "pop can"; two or more words beginning with the same letter (if possible) describing what it looks like, e.g., "crushed, curved"; and its exact location (described with alliteration in mind again), e.g., "in the crease of a tree." Teach the alliteration technique but tell students this is not a requirement of this particular exercise. (Have students put headings on cards before beginning.) Example:

   Name

   Litter: **pop can**

   Description (adjectives): **crushed, curved**

   Location (place found): **in the crease of a tree**

   Suggest students find four or more separate items and fill out a card for each. Discuss the information on the cards and ask students which items they found could be recycled.

5. Give students the handout, ***A-litter-ation Litter***. Have them complete the top half of the handout by transferring information from their

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cards. If students were unable to think of descriptions that made alliterations possible in regard to the observations they described on their cards, have them use their imagination now and add alliteration words (that may not, however, describe the observations recorded on the cards).

6. Help students write four examples on the bottom half of the handout, ***A-Litter-Ation Litter***.
7. Allow students to share alliterations and discuss effects of litter. Have each student choose his or her best alliteration and make a picture of it. Write the alliteration at the bottom of the picture. Put all pictures together as a magazine or post them around the room.
8. Have students apply the creative writing techniques learned in the above exercises by completing the handout, ***Lost In Litter***. Tell students to include lots of adjectives, synonyms and alliterations.

Evaluation

1. Have students describe ten places in their environment where litter is most likely to be found.
2. Have the students take a well-known nursery rhyme and reword it using recycling and anti-litter themes. Example:

   Jack and Jill
   Went up the hill
   To the recycling center.
   Jack brought cans and some old newspapers,
   While Jill with glass bottles came after.

FEELINGS ABOUT WASTE

I. Underline the word(s) in each sentence that relates to the subject of waste or is a synonym for the word "waste."

1. Bobby went fishing and saw trash dumped in the lake.
2. Sally's class picked up litter yesterday.
3. Jack takes the garbage out.
4. We recycle items that some people consider throw-aways.

II. Match the sentence completions on the right with the sentence starters to the left. Write the letter of the sentence completion in the blank to the left of the sentence starter it matches.

______	I see	A - decaying garbage and molding paper.
______	I hear	B - sad because we're destroying the earth.
______	I smell	C - trash and garbage littering the ground.
______	I feel (touch)	D - the smooth cans I am taking to the recycling center.
______	I feel (emotion)	E - the sounds of cans and bottles hitting our streets.

III. Think about litter prevention and recycling. Then finish these sentences in your own words.

1. It makes me angry when ______________________________

____

2. I am glad when ______________________________

____

3. My trash is ______________________________

____

4. The recycling center ______________________________

____

A-LITTER-ATION LITTER

NAME OF LITTERED ITEM	ADJECTIVES	PLACE FOUND
1.		
2.		
3.		
4		

Example of ALLITERATION:

Adj.	*Adj.*	*Noun*	*Verb*	*Adverb*	*Phrase about location*
soggy,	soppy,	straw	sitting	stupidly	on a slimy oak branch.

1. ______________________________

____

2. ______________________________

____

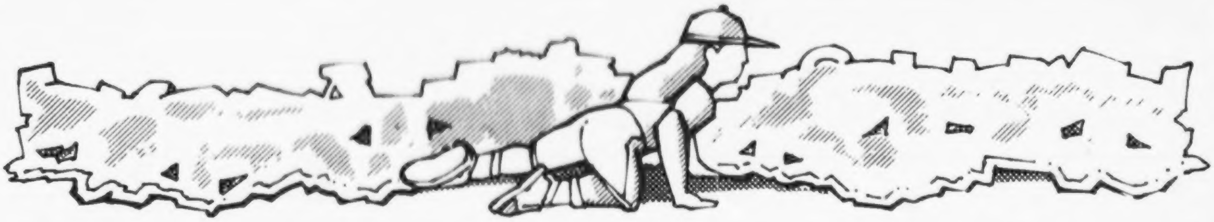
3. ______________________________

____

4. ______________________________

____

LOST IN LITTER



Are we the last people in a world of litter?

I found the following story piece below, but the ending was torn off. I searched and searched for the missing ending, but it was lost in litter. I'm sure that someone out there knows the ending. Write the ending in the spaces below.

It took years, but finally we have buried ourselves in litter. We travel from room to room through a maze of tunnels. The cement for these tunnels of litter is a paste of sour milk, old gum and moldy candy.

At 7:00 AM, I was beginning my morning crawl to the kitchen. I hadn't gone far when the little finger of my left hand got caught in the opening of an empty pop can. As I tried to free my finger, the can broke loose from the wall. Milk cartons, beer cans, a bicycle tire and old cardboard boxes closed in on me from all sides. The air was squeezed out of my chest. It began to rain . . . all the last drops of pop, milk and juices . . .

(Continue on back or separate sheet of paper.)

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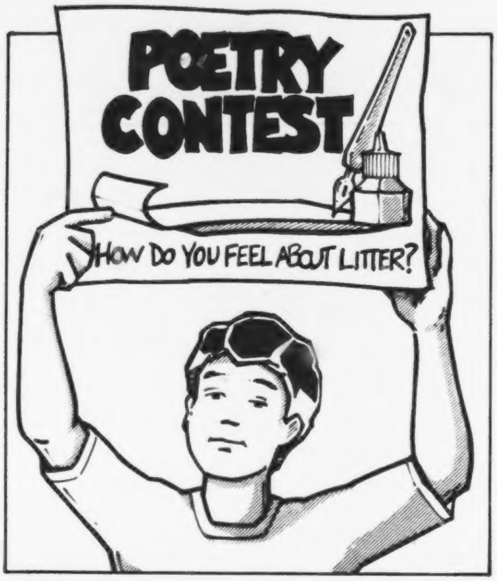
THE LITTER POET

CHAPTER **6**


POETRY CONTEST
HOW DO YOU FEEL ABOUT LITTER?

INTERMEDIATE

Objectives

Students will be able to express individual feelings about their discoveries of litter in the environment. Students will improve their ability to *write creatively*.

Method

Students *observe* and *describe* litter in select environments. They use these descriptions to express their feelings in various poetic forms.

Duration: eight class periods
Setting: classroom, home
Subjects: Social Studies, Language Arts
Curriculum Reference: 5.3

Preparation

There are four independent parts to this activity, each requiring different materials. *Letter Litter Labels*: need index size cards (or sheets of paper) each with a letter of the alphabet written in the corner (exclude Q, X, Z), a set of these will be needed for each student, a littered area, paper and markers; *Looney Limericks*: need limerick poetry books, littered area, paper sacks, paper and markers (or pens); *Maddening Metaphors*: need paper sacks, pens and paper; *Not So Heavenly Haiku*: need examples of haiku poetry, pictures of nature's beauty, pictures of dumps, landfills or littered areas, large cards and markers.

Vocabulary

haiku, limerick, litter, metaphor, recycle

Procedures

1. *Letter Litter Labels*: Distribute alphabetical cards to students, or have them make their own. In a limited, supervised outdoor environment, or at home environment, they need to search and find litter, named by their letters (e.g. C-can, P-paper, S-soda straw, R-rubber band). Have them identify on the card where the litter was found. Discuss examples in class and have students divide into groups to think of two or three adjectives to describe each item, e.g. "crushed, curved, *can*" or "still, sticky *straw*." Then have groups make poems from their descriptions, in the following manner, so that the letters of lines 2, 3, and 4 spell a word of an object which could be found as litter.

Line 1 — (Where) - Behind the tree were
Line 2 — crushed, curved cans
3 — awful, alarming articles
4 — not-so-nice, nasty newspaper
Lines taken from their cards
Line 3 — (Feelings) - We think it is horrible!

   Have students write out poems, display. They could draw pictures to accompany the poems.

2. *Looney Limericks*: After studying the limerick form of poetry, discuss rhyming pattern and use of nonsense to make poems. Do some examples. Have a ten minute outdoor search in groups of three or four. Each group chooses one piece of litter and names it, e.g. "Midge Match," "Cathy Cup," "Suzy Straw." Assign time for the group to compose a limerick about their piece of litter (There once was a match named Midge . . .). Share as a class. Display on a "Looney Limerick" board.

3. *Maddening Metaphors*: Have students gather litter from an assigned area and put in sacks. Return to class, and pass articles around to feel, touch, smell, and observe. Introduce the following writing form — adj., adj., noun "is a/an". . . adj., adj., noun. (E.g. A smelly, sticky,

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©1988 Ohio Department of Natural Resources; source: Kathleen E. Adams, Montgomery School (Ashland, Oh).

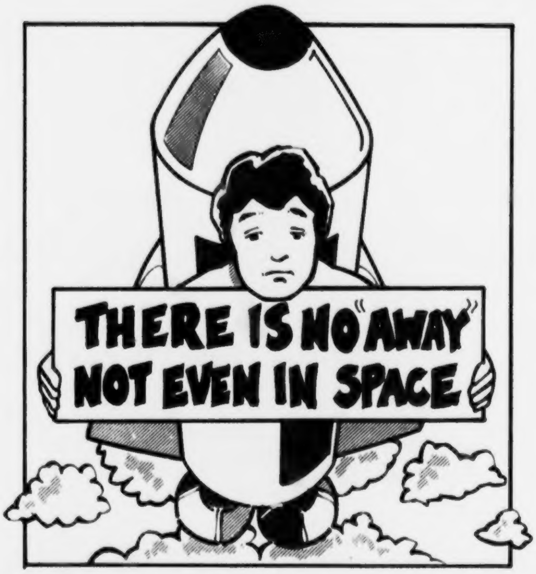
orange skin is a dry, dimpled golf ball.) Put together a class booklet of "Maddening Metaphors."

4. *Not So Heavenly Haiku*: Introduce haiku as a poetry form, which usually pertains to the beauty of nature. Teach the syllable pattern used, i.e. line 1: five syllables; line 2: seven syllables; line 3: five syllables. Have pairs of students compose their own poems concentrating on a beautiful part of the environment. Discuss and display. Next, display pictures of a *littered* environment, and divide students into pairs. Have them choose the picture they would like to write a haiku poem about. Assign time just to list words about their pictures. Discuss. Have them compose their haiku. Share and allow time for changes. On large cards have students write their final forms. Display on a large board.

Evaluation Have each student compose a poem of his or her choice, using whatever rhyming or non-rhyming pattern they want. The subject matter this time could be *recycling* and/or *litter*. Hold a contest to include a panel of judges and prizes. Make arrangements to display poems (with illustrations) in various places in the community. Initiate the activity to coincide with Ohio Recycle Month or Clean Up Ohio Week.

WASTE IN SPACE

CHAPTER **6**



INTERMEDIATE

Objectives Students will be able to: (1) *infer* future needs to dispose of waste; (2) *explain* reasons why we need to find alternatives for waste disposal; (3) *describe* alternative ways to dispose of waste in space; (4) *deduce* that recycling is the best alternative to any means of disposal when recycling is possible. Students will improve *problem solving* skills.

Method Students discuss problems associated with waste disposal. The problems associated with litter in space and disposing of waste in space are examined by reading a handout and answering questions to test comprehension. Students *draw* pictures of waste collection in space and *write* a story about their pictures. They discuss and take a poll about waste in space. Students explain why recycling is a good alternative to waste disposal.

Duration: five to six class periods

Setting: classroom

Subjects: Social Studies, Language Arts, Art

Curriculum Reference: 5.5, 8.1

Preparation writing and drawing materials; a map of the solar system; reference books about the solar system (optional)

Vocabulary disposal, incineration, landfill, orbit, recycle, solar system

Handouts ***Trashing the Heavens; Space Waste Collection***

Procedures

1. Discuss with students current problems associated with the disposal of waste. These should include the following:
   a. We are running out of landfill space to bury our trash and garbage.
   b. One alternative to burying waste is to incinerate it, but this can cause air pollution and there are still ash and residue to bury after waste has been burned.
   c. The history of the past fifty to one hundred years has shown that our waste production has increased; therefore, we have good reason to believe it will continue to increase in the future.
   d. Everywhere people go litter and waste seem to follow. Steps 2 and 3 below highlight waste problems in space: a current and future dilemma.
2. Initiate a discussion about our solar system. Show the class a map of the planets. Describe distances in space and special features of planets and stars. Describe various attempts that have been made to explore our solar system in manned spaceships and with satellites.
3. Mention that one effect of our space exploration has been a problem with waste in space. To help explain this, give each student the handout, ***Trashing the Heavens***, to read alone or as a class. Direct students to answer reading questions about the article and then discuss.
4. Divide students into groups to brainstorm problems associated with waste disposal and litter in space. After each group has listed some problems have them think of solutions that might still make waste disposal in space possible. Have each group make a short presentation to the class.
5. Give each student the handout, ***Space Waste***

source: John Memmott, Prospect School (Oberlin, Oh) and Rosalie Spencer, East Elementary (East Liverpool, Oh).

Collection, to complete. Note that this involves a written assignment as well as making a design on the handout.

6. Mention to students that one suggested alternative to our waste disposal problems is to ship waste into space. List alternatives: e.g., send into sun to be incinerated; send into deep space beyond solar system. Initiate a classroom survey regarding these proposals. Put two columns on the blackboard with the headings "*FOR* Space Disposal" and "*AGAINST* Space Disposal." Have students put their initials in the column they choose and give a brief reason why they have made this choice.

Evaluation

Have students answer the following question in writing: Why is recycling a better alternative to disposing of waste on earth or in space?

TRASHING THE HEAVENS

Directions: Read the news article and then answer the questions below on a separate sheet of paper.

NatureScope News — National Wildlife Federation (1986) Vol. 2 No. 2 *

There's a "down-to-Earth" phenomenon out there in space: litter. Old satellites, fragments of exploded rockets and other bits and pieces of junk are *in orbit* around Earth — and they're starting to create problems for functioning satellites, the space shuttle and other spacecraft.

In 1983, for example, the space shuttle Challenger had a "run in" with what researchers think was a tiny fragment of paint that had worn off of another spacecraft. Like all objects in space, the paint was traveling at a tremendous speed — so fast that it dented the shuttle's window when it smashed into it. Fortunately, the hurtling fragment didn't actually break the window. If it had, the crew of the Challenger would have been faced with a very dangerous situation.

In an effort to find solutions to the problem of litter in space, scientists at NASA have been trying to learn more about it. They've been using special telescopes to locate the orbits of pieces of junk — some of which are as small as a pebble. And a lot of people have been tossing around ideas about how to get rid of the trash.

One way of alleviating the problem might be to launch a kind of giant space trash collector. Using robot arms controlled from Earth, the device would go around picking up pieces of space junk. Then it would either guide the pieces into Earth's atmosphere, where they'd burn up from friction, or take them into an out-of-the-way orbit, where they'd be less likely to collide with spacecraft.

Other ideas for getting rid of space trash have also been proposed. Maybe one of them will solve the problem — before the sky above us turns into one big dangerous trash dump!

1. What does "*in orbit*" mean in the first paragraph? (Answer can be found in the second paragraph.)
2. Why is litter "*in orbit*" such a problem?
3. What is one way scientists have been using to learn more about the litter problem in space?

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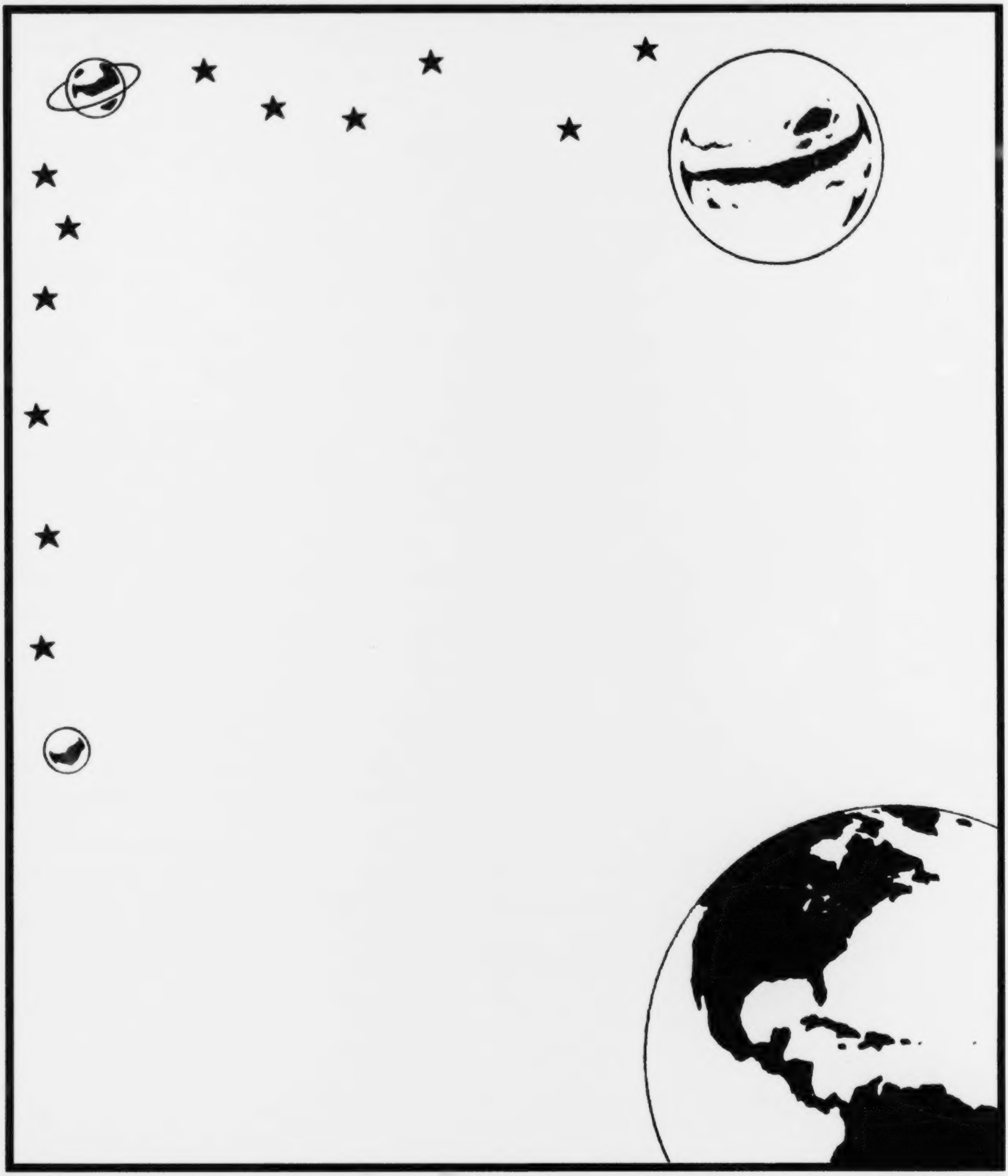
* Reprinted with permission from *NatureScope News*-Ranger Rick's *NatureScope*, "Astronomy Adventures," published by the National Wildlife Federation, copyright 1987.

SPACE WASTE COLLECTION

Directions: Design a machine or vehicle that could collect space litter. Then on a separate piece of paper write a fictional story about a day in the life of a space garbage collector.



Chapter 7

Unnatural Hazards in Nature

UNNATURAL HAZARDS IN NATURE

CHAPTER 7

Improperly disposed of solid and hazardous wastes are harmful to wildlife. Litter is misplaced human-made solid waste, and it harms wildlife in forests, on beaches, at sea and in urban areas. Some ***accidents*** that happen to animals are well known, such as cuts received from broken glass or sharp edges on cans. Other lesser known incidents also take place. For example, when mistaken for food, bottle caps eaten by fish or styrofoam cups eaten by deer cause internal problems for these animals.[1] Small rodents, such as mice and chipmunks, can become trapped in glass bottles because they are unable to get a footing on the slippery glass to push themselves out.[2]

Plastic litter, because it is buoyant and floats, is a threat in waterways. It has been described as "individual mines waiting for victims."[3] "A number of scientists believe that plastic is the most far-reaching, man-made threat facing many marine species, annually killing or maiming tens of thousands of seabirds, seals, sea lions and sea otters, and hundreds of whales, dolphins, porpoises and sea turtles."[4] Destruction to aquatic life by plastic litter often happens in tortuous ways. Six-pack beverage holders and plastic gaskets are frequently found lodged tightly behind the gills of dead fish washed up on shorelines. In this instance the fish, while still young, dart into the circular trap. As they continue to grow, the plastic noose slowly cuts off the animals' supply of oxygen. In similar fashion, birds, especially gulls, become encircled by plastic rings which impair their ability to fly and to breathe. Researchers are seeking new ways to deal with the problem of plastic litter, such as making plastic containers which are photodegradable. These will deteriorate, when left exposed to sunlight. Other plastics which would deteriorate in salt water are also being studied.

Other problems for wildlife are created by improper disposal of hazardous wastes. High level doses of hazardous wastes released into an animal's environment can have sudden and horrible effects, such as massive fish kills in streams and lakes. Prolonged exposure to low level doses of hazardous chemicals also affects wildlife, and humans, through a process known as ***bioaccumulation***. This happens in the following manner: Small organisms like plankton ingest and store minute amounts of hazardous chemicals spilled into waterways. The plankton is eaten by small fish which in turn are eaten by larger fish. Each time one animal becomes food for another higher on the food chain, the hazardous chemical becomes more concentrated in the tissues of the predator. This is why some fish from lakes and rivers which have become polluted are unsafe for humans to eat. In some cases, predators also become ill, develop tumors or give birth to young with defects.

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[1] *Project Wild: Elementary Activity Guide*, Western Regional Environmental Education Council, 1983, p. 52.
[2] Ibid.
[3] Michael Weisskopf, "Plastic reaps a grim harvest in the oceans of the world," *Smithsonian* 18 (March 1988), p. 61
[4] Ibid.

WHAT'S UNDER WATER?

HELP!
LITTER
OVERBOARD

PRIMARY

Objectives

Students will be able to: (1) *explain* how waterways become littered; (2) *suggest solutions* to keep from polluting our beaches and waterways. Students will improve their abilities to *solve problems* and *write creatively.*

Method

Students *infer* whether objects will float or sink and observe them when placed in an aquarium tank in the classroom. They complete handouts to show where litter can be found and what should be done with it. They *observe* a demonstration to compare the degradability of waste on land with the degradability of waste in water.

Duration: four class periods

Setting: classroom

Subjects: Social Studies, Science, Language Arts

Curriculum Reference: 3.1, 3.4, 5.1

Preparation

Put 2″ of gravel in an aquarium. Add water to fill to ³/₄ full. Collect the following: plastic 6-pack holder, empty aluminum pop can, empty tin can, empty plastic 2-liter pop bottle, metal bottle cap, empty glass pop bottle and metal can opener. For an additional demonstration you will need some organic garbage (paper, vegetable scraps, wood) and another set of each of the items listed above. Also, a container with soil will be needed.

Vocabulary

beach, float, lake, litter, ocean, recycle, river, sink

Handouts

Keep Our Water and Beaches Clean; Unhappy at the Bottom

Procedures

1. Display the seven litter items next to the aquarium. Ask students which items will float and which items will sink when placed in the water. Record their responses. Student volunteers place each item in the water (one at a time) and observe what happens. Record results and compare with initial inferences the students made.

2. Point out that some empty containers may fill with water and sink. The time they take to sink may vary based on certain conditions, such as rough water or human manipulation.

3. Have students make a list of litter that may be under water in lakes and rivers. Discuss the consequences of this. (Fish can be killed if they get stuck in a six-pack ring holder, people can be hurt by broken glass in swimming areas.)

4. Distribute the handout, ***Keep Our Water and Beaches Clean***. Give students time to complete the handout. Then ask what is missing from this picture which could help prevent littering (waste containers on land, litter bags in the boat, less use of throw-away containers and eating uten[illegible], a recycling collection bin).

5. Set up a demonstration to compare the degradability of solid waste in water with the degradability of solid waste in land environments. Add half of the organic garbage items to the aquarium which already has inorganic objects in it. Put an additional set of the inorganic items along with the rest of the organic garbage in a container (dishwashing pan, etc.) with soil. Let items rest on top of soil or push them into soil slightly. Have students compare rates of decomposition over a period of time.

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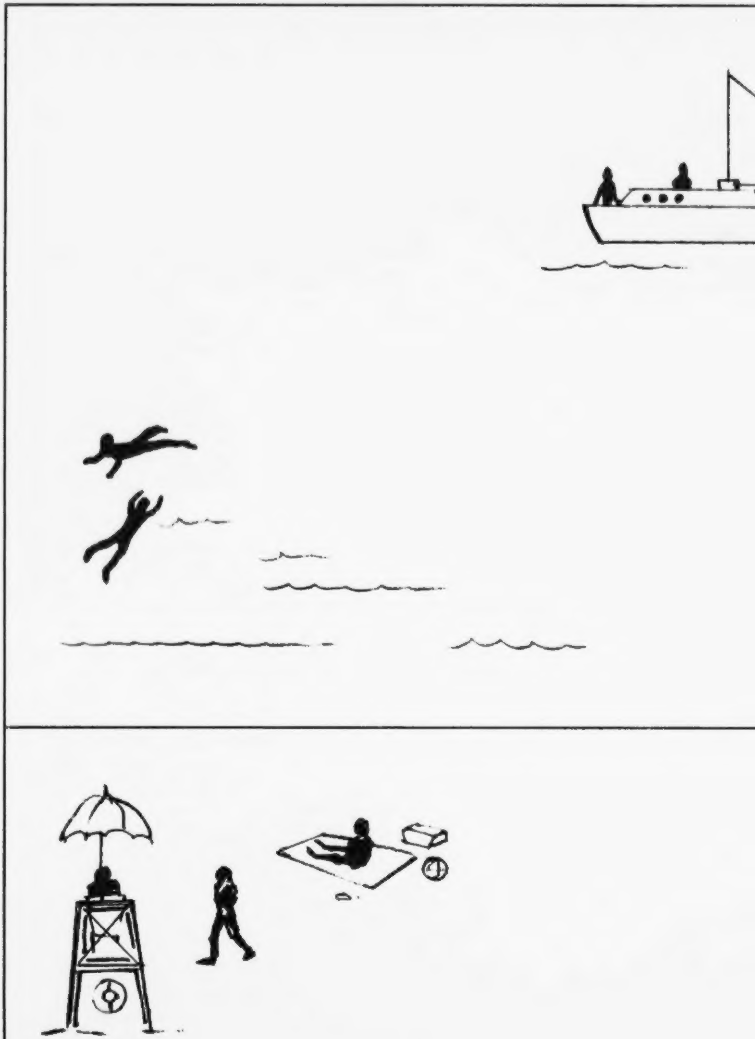
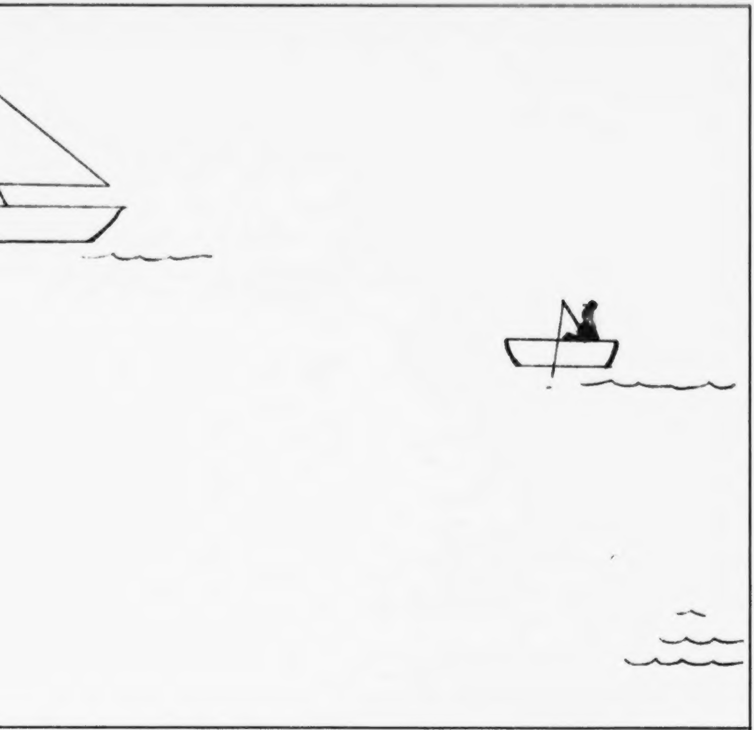
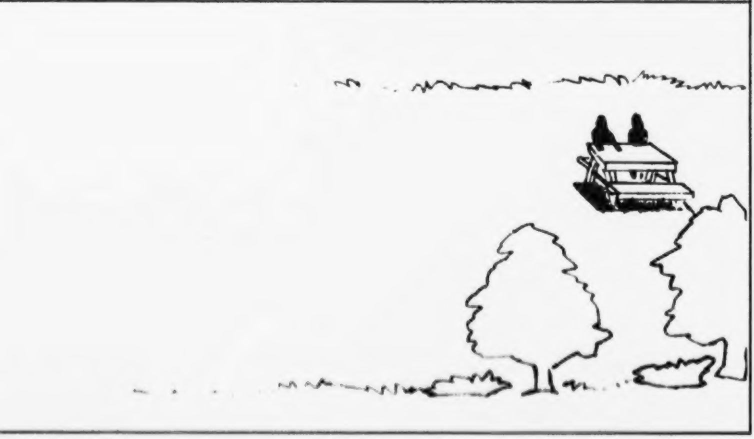
Evaluation Have students complete the handout, ***Unhappy at the Bottom***. Discuss answers in class. This could be done orally, or in writing.

Directions: Look at the swimmers, the boaters and th
Draw the littered objects close to the group responsib



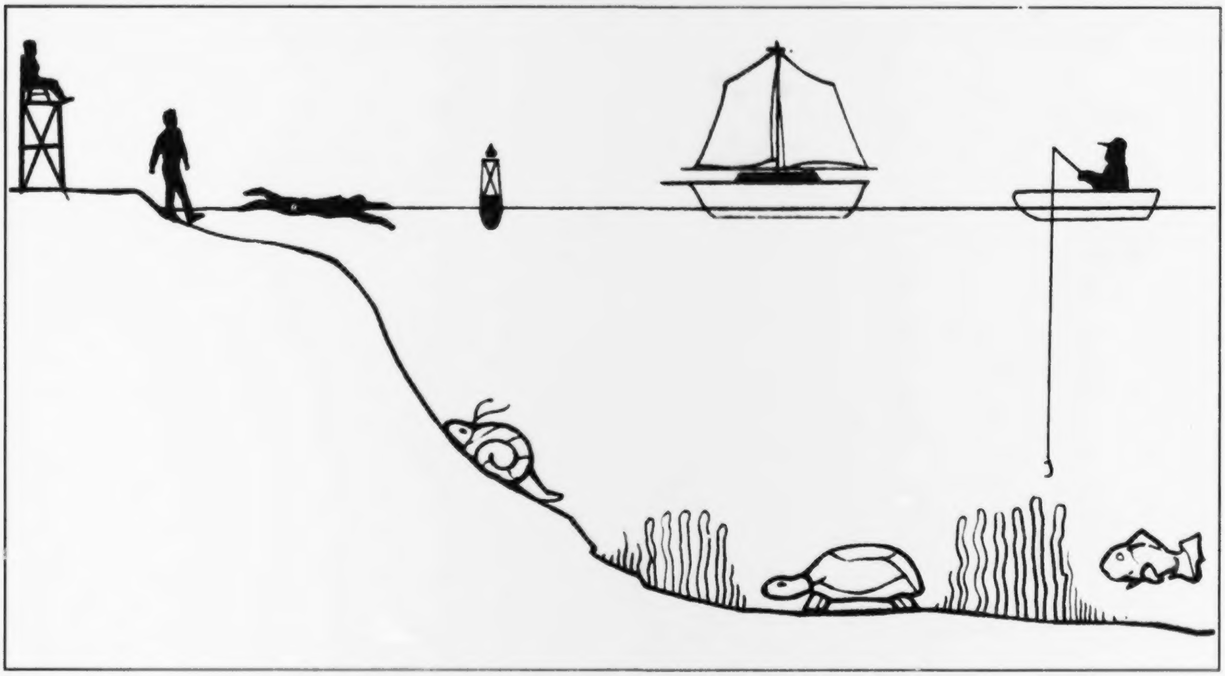
ne picnickers. Draw pictures of items each might litter.
ple for them.





UNHAPPY AT THE BOTTOM

Directions: Draw some litter in the water. Write what the animals think about it in the spaces below the picture.



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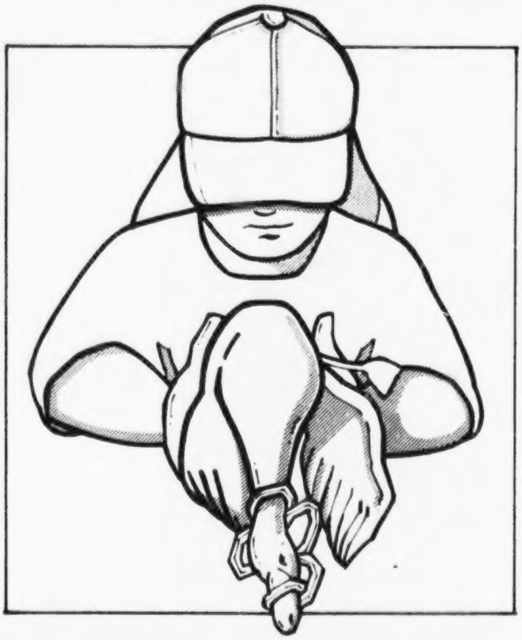
HOW DID THIS HAPPEN?



PRIMARY/INTERMEDIATE

Objectives

Students will be able to *describe* how litter can harm animals. Students improve their ability to *manipulate materials*.

Method

Students *deduce* how litter can affect animals. They construct pictures illustrating the harm litter can do to animals and they write captions for their pictures.

Duration: two class periods

Setting: classroom

Subjects: Science, Art, Language Arts

Curriculum Reference: 3.4

Preparation

assortment of trash including such items as bottle caps, pieces of plastic wrap and aluminum foil, food and beverage cans, plastic six-pack carriers, wire, nails; one 12″ × 18″ piece of drawing paper per student, crayons, masking tape, glue

Vocabulary

harmful, litter, wildlife

Procedures

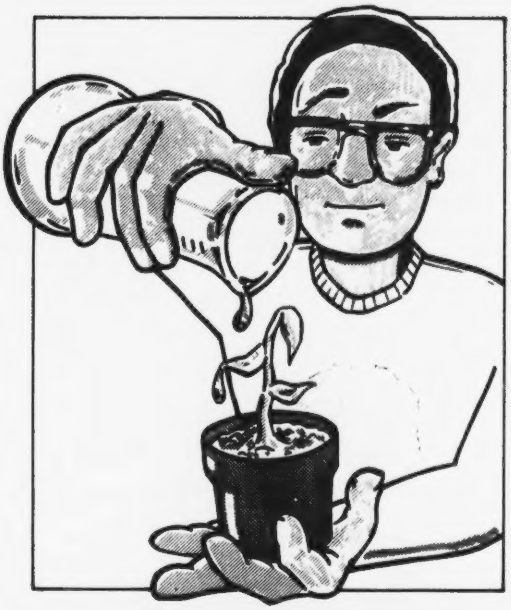
1. Discuss with students how animals meet their needs for food and safety (they digest food and they move). Explain how littered, unnatural objects might cause problems for animals when they eat or move.
2. Have each student choose a piece of litter from an assortment provided by the teacher (insures variety and safety), and to think of an animal he or she likes.
3. Have each student draw a picture depicting what harm *could* happen to the animal upon coming into contact with the chosen piece of litter.
4. Have each student attach the piece of litter onto the paper with the picture and explain the picture to the class. Students could imitate how their animals would move before and after injury.
5. Hold a group discussion about what could be done to avoid the problems litter can cause for wildlife.
6. Have students write questions from the animal's point of view to accompany their pictures. The questions should reflect the actions depicted in their pictures. (e.g. "Why didn't that human throw that bottle in the trash can? Then I wouldn't have cut my paw.")
7. As enrichment, ask a naturalist from a park or a representative from the Humane Society to relate stories about animals found dead, injured, or in danger because of what people have done to the animal's habitat.

Evaluation

Have each student list one waste item that they think is the most harmful of all to animals when littered and explain why. In groups you could have students rank order a variety of waste items based on their potential to harm wildlife.

source: Martha Leuzinger, Charles T. Young Elementary School, (Cleves, Oh).†

DEADLY DRINK



INTERMEDIATE

Objectives

Students will be able to: (1) identify sources of environmental pollution caused by solid waste; (2) *infer* the effects of improperly disposed waste upon living things in the environment. Students will improve their abilities to *manipulate materials* and *conduct an experiment.*

Method

Students observe and make inferences about the effects of pollution on plants. They take measurements, *collect data* and *form conclusions.* They distinguish cause and effect by analyzing sentences.

Duration: two class periods and follow-up twice a week for four weeks

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 2.3, 3.2

Preparation

Gather bean seeds, cups, soil; have each student plant a germinated bean seed in soil in a cup. Water as directed on package. At the end of two weeks, group plants that are similar in size in groups of four. Before proceeding, you will need the following: one pint jar per plant, motor or household oil, vinegar, laundry detergent, water.

Vocabulary

cause, effect, experiment, pollution

Handouts

Data Worksheet; Cause and Effect and Pollution

Procedures

1. Students work in groups of four.
2. Each student in the group fills a jar 3/4 full with water. Have students label their jars: one will label a jar "Plant A," another "Plant B," one "Plant C" and one "Plant D."
3. Students in each group with the jar labeled Plant A will add 1 Tbs. of oil to the water. Students with "B" will add 1 Tbs. laundry detergent. Students with "C" will add 1 Tbs. vinegar and students with "D" will add nothing.
4. Have each student select a plant from the four in the group and label it with the same letter of his or her watering jar. Keep group plants together in a place where they will receive the same amount of sunlight.
5. Have students in each group water their plants with the matching container. (Water Plant A with Jar A, etc.) Make sure all follow the same procedure adding the *same amount* of water each time the plants are watered. Be sure to shake or stir each jar before watering.
6. Ask students to infer what they think will happen to their plants in the next few weeks. Record their inferences.
7. Have each student keep a record of each plant (A, B, C, D) in his/her group twice a week (see handout, ***Data Worksheet***). They are to note changes in the plants. Keep records until some plants die or begin to die.
8. At the end of record keeping have students discuss and decide which plant is the healthiest and which the least healthy. Have students rank plants from healthiest (#1) to least healthy (#4) and give explanations about what they think happened. Next, have students predict what would happen to plants and animals living in water containing the various ingredients used in the experiment.

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9. Discuss the following questions:
   1. Why did we use oil, vinegar and detergent to add to water for the plants? (These are representative of chemicals that often end up in our waterways and in the ground.) Ask students how these substances can enter our waterways or soil. (Littering, spills, improperly maintained garbage dumps or sewage treatment plants.)
   2. What are possibilities for solving or helping solve the water pollution problem? (How can we control the flow of wastes from litterers, landfills, factories and businesses so we will not contaminate our soil and waterways?)

Evaluation

Have students complete the handout, ***Cause and Effect and Pollution***. Before students work on this handout, you will need to define the words in italics: sewage, pesticides, toxic, phosphates, algae, leachate. (See Background Information of Chapter 8 for explanations of these terms.) You could also have students look up these words in dictionaries before they begin working on the handout.

DATA WORKSHEET

A. Plant Observations

1. Look at each plant very carefully.
2. Record results such as height (use centimeter ruler), color, whether plant seems wilted or not. Write any other information about your plant that you think is important.

DATE	Plant A (oil in water)	Plant B (detergent in water)	Plant C (vinegar in water)	Plant D (clean water)

B. After completing the above chart, talk with your group and come to a conclusion on how to rank (put in order) which is the healthiest (#1) to the least healthy (#4). Put letters of plants in the blanks below.

#1 ________ healthiest

#2 ________

#3 ________

#4 ________ least healthy

C. Explain on the back of this sheet why you think #1 was the healthiest and #4 the least healthy. Also, explain what you think would happen to an animal that drank #4 water or ate #4 plant.

CAUSE AND EFFECT AND POLLUTION

Directions: Read the sentences below. In each sentence, underline the cause and circle the effect.

1. Fish and plants can become sick or die because improperly treated *sewage* from sinks and toilets in some cities flows into streams, rivers and oceans.

2. Since wastes flow into the stream, the water in the stream is not safe to drink.

3. Rivers can become polluted if *pesticides* are washed off the land into them.

4. The factory was dumping *toxic* chemicals into the stream, so fish and plants died.

5. *Phosphates* from detergents, when dumped into rivers, make *algae* grow rapidly.

6. As algae grow they use the oxygen needed by fish, so fish sometimes die.

7. Wastes buried in a landfill combine with water from rainfall to create a polluted mixture called *leachate.*

8. The underground water well became polluted when leachate seeped through the bottom of the landfill.

Choose two of the sentences above. For each write a sentence telling what could happen next. Continue each sentence on the back if you need more space. Write the number of the sentences you choose in the parentheses.

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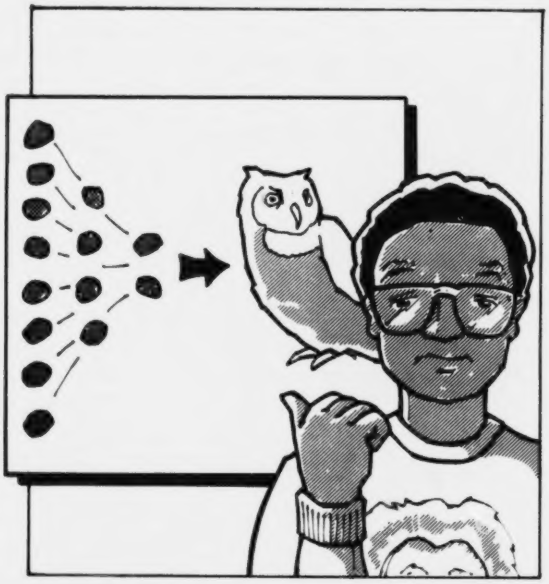
CONCENTRATED CHEMICALS

CHAPTER 7



INTERMEDIATE

Objectives

Students will be able to: (1) *describe* how hazardous waste can end up in wildlife habitats; (2) *explain* how harmful chemicals affect food chains. Students will improve their abilities to *make inferences* and *cooperate in groups.*

Method

Students participate in a simulation to discover the meaning of bioaccumulation and bioconcentration. Through discussion and handouts students will *predict* what can happen to a food chain in a polluted environment.

Duration: three to four class periods

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 3.1, 3.2, 4.1

Preparation

8 five-ounce cups, 4 eight-ounce cups, 2 fifteen-ounce cups, 1 quart container, 8 brown beans and 8 white beans per group.

Vocabulary

bioaccumulation, bioconcentration, carnivore, chemical effect, contamination, food chain, habitat, hazardous waste, herbivore, litter, physical effect, producer

Handouts

Don't Break the Chain; It All Adds Up

Procedures

1. Discuss the effects of litter and waste on wildlife and explain what hazardous waste is. (Many types of litter can be physically harmful to animals, but hazardous waste is chemically harmful to them.) Give examples of how litter can be physically harmful to wildlife.

2. Explain to students the following two terms as important for understanding how waste can be chemically harmful to wildlife.

   Bioaccumulation — the accumulation inside a living creature of a chemical that cannot be metabolized or excreted before more of it enters the organism. The substance is then stored in some body part, often fatty tissue or bones.

   Bioconcentration — is the passage of bioaccumulation up a food chain, resulting in greater and greater concentration of contaminants in animals.

   Tell students they will now engage in an activity that demonstrates the process of bioconcentration.

3. Divide the class into two groups of fifteen students. (If you do not have enough students for two groups, you will still need one group of fifteen students while the others observe.) Arrange students in pyramid fashion. Give eight of them a five-ounce cup each, give four of them an eight-ounce cup each, give two of them a fifteen-ounce cup and give one a one-quart container. You will also need eight brown beans and eight white beans for each of the two groups.

4. Tell students they will use cups and beans to show how a harmful chemical can concentrate in a food chain.

   a. 8 five-ounce cups — represent aquatic plants such as algae.
   b. 4 eight-ounce cups — represent aquatic insects.

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   c. 2 fifteen-ounce cups — represent fish.
   d. 1 quart container — represents an eagle.
   e. 8 brown beans — represent useful food value in tissue.
   f. 8 white beans — represent a chemical that bioconcentrates in plant and animal tissues.

   Give each of the eight students in the group that represents a plant (ones with the five ounce cups), one white bean and one brown bean.

5. Explain to students that in this food chain each insect eats two aquatic plants, each fish eats two insects, and the eagle eats two fish. The brown beans and cups are digested and used by each member in the food chain, but the white beans bioconcentrate. Before beginning, have students infer what type of pollution the white beans might represent. (pesticides used on fields near water, leaking toxic waste from drums at an improperly controlled dump near the water, or leachate from a solid waste dump) Proceed with the activity in the following steps:
   a. Each aquatic insect receives four beans from two aquatic plants (a white and a brown bean from each plant).
   b. Have each aquatic insect take out one of the brown beans. Ask why? (represents food burned up as energy by the insect) Why does one brown bean remain? (represents food stored which helps the insect grow)
   c. Each fish receives six beans from two aquatic insects (one brown bean and two white beans from each insect).
   d. Have each fish take away one of the brown beans. Ask students what this represents as discussed in "b."
   e. The eagle receives ten beans from the two fish (one brown bean and four white beans from each fish).
   f. Have the eagle take away one of the brown beans and tell what this represents. Why is one brown bean left? Ask the eagle how many white beans are in his or her cup. What does this represent? (bioaccumulation of a harmful chemical) Ask students what the steps in the exercise represented? (bioconcentration) Which beans bioconcentrated? (the white ones)
6. After enacting the sequence have each student complete the handout, ***It All Adds Up***.
7. Refer to the handout and ask students how *people* might be affected by the pollution in this food chain. (They could consume harmful chemicals by eating the fish.)
8. Discuss with students how the improper disposal of hazardous waste resembles littering behavior, but a more dangerous form of littering.

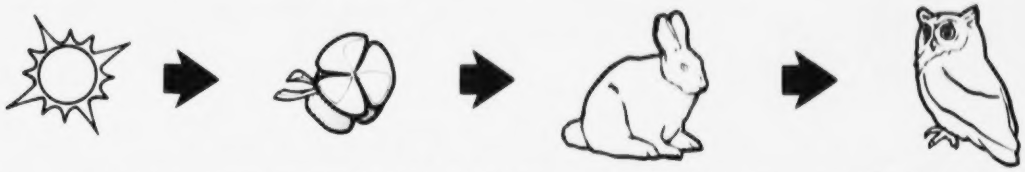
Evaluation Have students complete the handout, ***Don't Break the Chain***.

DON'T BREAK THE CHAIN

Directions: Read the passage below and answer the questions that follow.

All energy starts at the sun and is passed along the food chain. Producers are the first part of any food chain. Producers are plants that change the sun's energy into other forms of energy that is passed on as the plants are eaten. The next part of a food chain are the herbivores. Herbivores are animals that eat producers. They get their energy only from producers. Carnivores are mostly animals that eat only herbivores. They get their energy from the herbivores. A sample food chain would be:

SUN *Producer*: Clover *Herbivore*: Rabbit *Carnivore*: Owl



1. In complete sentences, explain how each member in the sample food chain gets its energy. Use the words producer, herbivore or carnivore in each sentence.

Clover:

Rabbit:

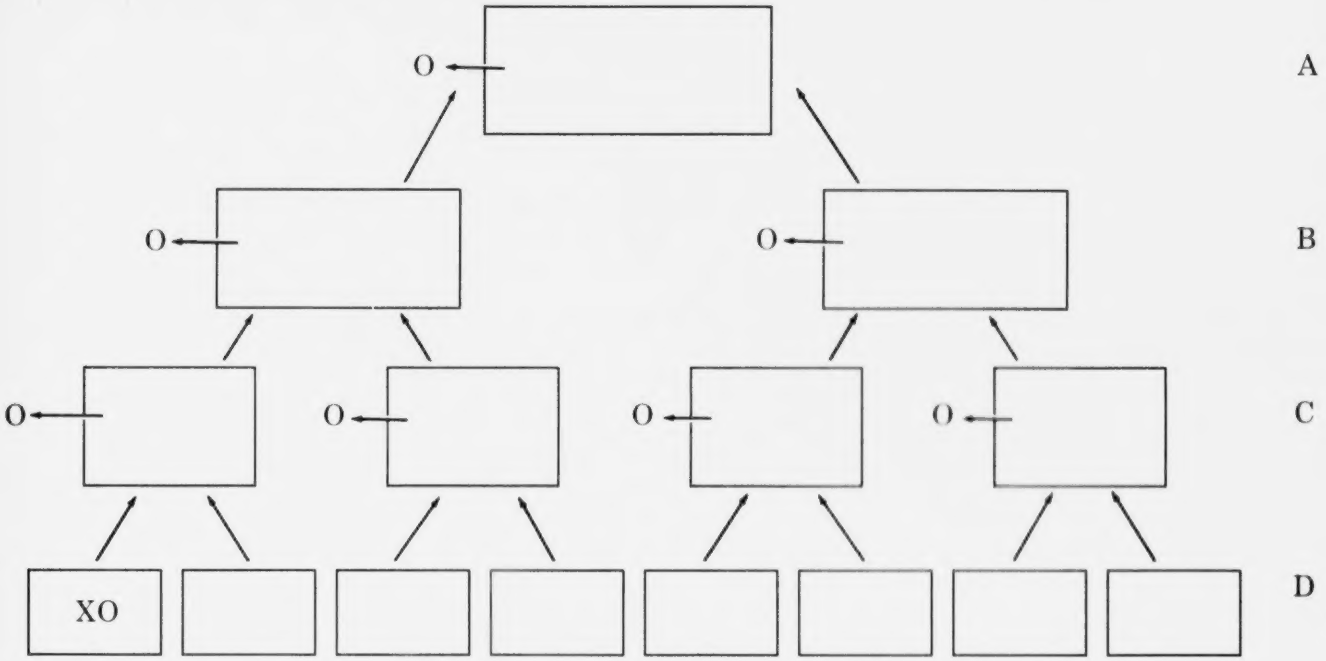
Owl:

2. How might the clover become contaminated by harmful chemicals?

3. If the contaminated clover dies, what will happen to the rabbits and owls? (Answer this question on the back of this page.)

IT ALL ADDS UP

Directions: Answer the questions in Part A below and then fill in the boxes with X's and O's to represent what happened in the activity. The X's represent the white beans (pollution) and the O's represent the brown beans (food). Then answer Part B.



PART A

What living organisms do the boxes in row "D" represent? ____________

What living organisms do the boxes in row "C" represent? ____________

What living organisms do the boxes in row "B" represent? ____________

What living organism does the box in row "A" represent? ____________

PART B

Explain what happens to the brown (food) and white (pollution) beans as they move up the food chain.

(continue answer on back)

Chapter 8

Hazards in the Built Environment

CHEMICALS AND WASTE MATTER: SOURCES OF POLLUTION

CHAPTER **8**

Chemical Compounds and Hazardous Waste

All the materials we throw away — paper, glass, plastic, make-up, paint thinner — are composed of chemical parts called ***elements***. There are 92 elements that occur in nature and thirteen others that have been made by humans in laboratories. Some examples of elements are oxygen, hydrogen, iron and aluminum. Elements are rarely found in their pure natural state. Rather, they are usually found as different combinations of elements known as ***compounds***. Water is a compound made up of oxygen and hydrogen, each of which can be separated from water in a special process. In order to obtain pure aluminum, aluminum must be separated from the compound aluminum oxide found in bauxite or aluminum ore. Some compounds, such as cellulose found in wood, are natural. Others, such as plastic, are human-made.

There are two types of compounds: organic and inorganic. ***Organic compounds*** contain elements such as carbon, nitrogen and oxygen and are associated with living organisms. Paper is an organic material made from the organic compound cellulose found in wood fiber. Plastic is an organic material made from the organic compound petroleum which was created over millions of years from decaying plant and animal matter. ***Inorganic compounds*** do not contain the element carbon and are associated with elements (such as iron and copper) that are not produced by living cells. Glass is an inorganic material made from the inorganic compound sand.

Materials made from organic compounds break down or decompose in different ways than do materials made from inorganic compounds. Organic compounds can usually be broken down by organic or living organisms such as fungi and bacteria. Paper containing the compound cellulose is broken down in this manner. Inorganic compounds require the action of sun, wind, water and/or oxidation (rusting) to break down. Iron, an inorganic element in steel, is susceptible to rusting. Some organic and inorganic compounds defy the general rule noted above and are hardly susceptible to decomposition of any natural kind. Plastic is an example of an organic material which is impervious to organic decomposers such as bacteria and fungi. Glass is an inorganic material impervious to weathering. That plastic and glass (human-made materials) are so durable compared to wood or other elements found in nature, indicates what humans can do with natural elements to make chemical compounds that are stronger and more persistent than those which exist in nature.

Some compounds are used in different ways to either form substances and materials that are safe or form substances and materials that can be hazardous to human health. Plastic, made from the chemical compound petroleum, is nonhazardous (unless it is burned). Motor oil, which is also made from petroleum, is a hazardous substance because it can be toxic. A product or waste material is considered hazardous if it exhibits one or more of the following characteristics:

Ignitability	Substances that can create fires under certain conditions.
Corrosivity	Substances that are capable of corroding metal.
Reactivity	Substances that can create explosions and/or harmful fumes or vapors under normal conditions.
Toxicity	Substances that are harmful or fatal when ingested or absorbed.[1]

Adverse effects on human health from exposure to toxic chemicals or to air and water polluted by toxic chemicals can include damage to living tissue, impairments to the central nervous system, illness, birth defects and death. The amount of any one toxic chemical which can cause harm to human health varies with the nature of the substance, the route of exposure and the length of exposure. Two general effects of exposure to toxic substances can be identified: effects termed acute and effects termed chronic.

Acute effects (or ***acute toxicity***) refers to any harmful effect produced within a short period of time, usually 24-96 hours after contact with a toxic substance, resulting in severe biological harm and often death. We are familiar with many chemical products in our homes that could have these toxic effects; they contain warning labels about ingestion and inhalation. *Chronic effects* (or ***chronic toxicity***) refers to any harmful effect produced after a long period of time, usually resulting from repeated exposure to low concentrations of a toxic substance. Chronic effects can happen by drinking contaminated water or working over a long period of time with construction materials that contain toxic substances.[2]

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[1] *Solving The Hazardous Waste Problem: EPA's RCRA Program* (U.S. EPA: November, 1986), p. 5.

The use of some toxic chemicals has been banned because of the threats to human health. Asbestos has been banned from use in many products and is being eradicated from buildings where it was used in insulation. PCB's, traces of which are found in the blood and fatty tissues of most people, have also been banned. Yet, many chemicals which have been banned still exist in our environment, in products made before bans were initiated and in dump sites that have yet to be cleaned up.

One of the major problems with products made from toxic chemical compounds is that eventually they must be disposed of in the environment. Many chemicals identified by the EPA as toxic are disposed of by industries and businesses in special ways so that they are carefully monitored and controlled to prevent environmental damage. But toxic substances found in many consumer products, such as shoe polish and oven cleaner, are often thrown away with household waste. These ***household hazardous wastes*** are often disposed of in the ground in sanitary landfills. Although sophisticated control techniques are used in many sanitary landfills, these landfills are not as rigorously designed and monitored as are "secure" landfills, designed specifically to handle hazardous waste. This means that careful treatment and disposal of household hazardous products by consumers is becoming increasingly important. More about this will be discussed below, including a guide to the disposal of household hazardous waste.

We really can't say for sure what happens when the leftover contents in containers for toilet bowl cleaners, paint solvents, shoe polish, detergents, household bleach, metal cleaners and antifreeze are buried in the ground. Furthermore, we can only speculate about the hazard and toxicity of the mixture of these chemicals with rain and surface water that percolate through a landfill and form a substance called ***leachate***. We do know that each of these products individually is hazardous in some way. And many of the chemicals used in these products are very persistent, meaning they are not broken down by temperature changes, alkalinity or acidity, or by micro-organisms, except over a very long period of time. In addition, some parent compounds in the degradation process break down into other compounds that are more toxic or persistent than the parent compounds.

Many hazardous materials and substances have been identified and their disposal is strictly regulated. But the number of chemicals is very large: 4 million have been registered with the American Chemical Society; 60,000 different ones are produced annually; and thousands of new chemicals are developed each year. Testing for the effects of these chemicals upon health and environment, separately and/or in mixtures, lags far behind production and disposal. Once a substance leaks from its jar or can, whether disposed of properly in landfills, incinerators or storage facilities, or disposed of improperly in sewers, waterways, or backyards, it becomes very difficult to predict changes that may happen to it which can affect the environment and human health. Climate, temperature, acidic and alkaline conditions, as well as plants and micro-organisms are variables to be considered. And the chronic effects of harmful substances may not be discovered until unfortunate results have appeared. (DDT was used for 30 years before its long-term toxic effects and movement up the food chain became known.)

The most important concern about the land disposal of wastes containing toxic substances is the effect of improper waste disposal upon one of our most valuable resources: water.

Water and Toxic Waste

Fresh water is a major Ohio natural resource. There are 44,000 miles of rivers and streams; 60,000 lakes, ponds and reservoirs; 28 major aquifers; and 3,500 square miles of Lake Erie in Ohio. Protecting this valuable resource from pollution is a major concern.

Recently, the pollution of ***groundwater*** (water which fills the spaces between particles of soil and rock underground) has become one of the major environ-

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[2] Some common toxic chemicals found by the EPA when they are called to clean up a toxic dumpsite include asbestos, arsenic, formaldehyde, polychlorinated biphenyls (PCB's), lead, mercury, carbon tetrachloride and vinyl chloride. These chemicals have been (and some still are) used in various products such as clothing and electric hair dryers (asbestos); pharmaceuticals and pesticides (arsenic); plywood, plastics, room deodorants, cosmetics (formaldehyde); lubricants and caulking (PCB's); batteries and pigments (lead); thermometers, batteries, pharmaceuticals (mercury); metal degreasers and agricultural fumigants (carbon tetrachloride); food packaging and aerosol containers (vinyl chloride). Depending on the extent and duration of exposure to the chemicals in these products human health can be affected in different ways: lung cancer and respiratory problems (asbestos); birth defects and skin cancer (arsenic); fatigue, eye irritations and respiratory problems (formaldehyde); liver damage and cancer (PCB's); brain and bone damage (lead); kidney damage and birth defects (mercury); damage to central nervous system (carbon tetrachloride); lung cancer and liver cancer (vinyl chloride).

mental issues confronting the nation. In Ohio, nearly 40% of the population uses groundwater from wells for drinking water and household uses. The majority of this water is found in ***aquifers*** (large underground reservoirs of water in layers of porous rock). Two sources of groundwater pollution are solid waste landfills and hazardous waste sites, including hazardous waste landfills. Under certain circumstances leachate, which forms in landfills, has the potential to reach both shallow and deep aquifers. Guidelines have been established by the EPA requiring landfills to be built with clay or synthetic liners to reduce or collect leachate and to protect groundwater.[3] Ohio has over 150 solid waste landfills that accept municipal and commercial solid waste; but most of these were constructed before the EPA guidelines were developed.

As in the case of older municipal waste dumps, older hazardous waste dumps and chemical ponds received (and some continue to receive) unknown quantities of waste prior to the issuing of EPA guidelines in 1978. Ohio is a major hazardous waste generator and a center of hazardous waste disposal. There are approximately 75 permitted Ohio hazardous waste facilities that meet EPA recommended guidelines, including groundwater monitoring. However, in 1986, there were also 30 hazardous waste sites in Ohio that were listed on the Federal EPA's National Priorities List (NPL) for special cleanup. And there are 850 additional sites which need further investigation to determine if cleanup is necessary.[4]

Another important source of drinking water is ***surface water***. Surface waters in Ohio, including rivers, streams, lakes and ponds, have become polluted with a variety of chemicals from households, businesses and industries. For example, approximately 400 toxic chemicals have been found in the Great Lakes.[5]

Three categories of pollutants can be found in many of our waterways. They are nutrients, toxic organics and toxic metals. ***Nutrients***, mainly phosphorous, come from human and animal excrement, agricultural fertilizers and household detergents that are released into lakes and rivers from sewage which is not always properly treated or from storm sewer drains or from agricultural land. Nutrients act as a fertilizer for algae and other aquatic plants which multiply rapidly reducing the amount of oxygen available for fish and other living organisms. This creates an aging process, referred to as ***eutrophication***, which causes a reduction in life in lakes and streams and a deterioration in the water quality that affects drinking water.

Toxic organics are found in waterways in the form of pesticides and other chemicals that wash from agricultural lands and from improperly controlled industrial waste sites. Many very toxic pesticides, such as DDT and aldrin, have been banned. Although these can still be found in waterways because they don't break down easily, their levels are now considered safe in most locations.

Toxic metals (often called heavy metals), such as mercury, lead, cadmium, and others usually work their way into waterways through the disposal of industrial wastewater. Mercury, a very harmful substance that can cause brain damage and birth defects, was so prevalent in Lake Erie in the early 1970's that a ban on fishing was imposed. Although the levels of mercury and other pollutants in Lake Erie have decreased substantially, mercury is still washing into the lake from contaminated sediments upstream in Lake St. Clair.

Solid and Hazardous Waste Disposal: What can be done to protect health and the environment?

What makes most hazardous wastes difficult to dispose of is that they cannot be broken down easily, or even at all, by microbes such as bacteria or by weathering processes. Scientists are just beginning to study the subject of the ***biological treatment*** of hazardous chemicals. In the future, tiny bacteria may help solve hazardous waste problems by ingesting certain types of harmful organic chemical wastes and changing them into harmless substances. The biological treatment of hazardous waste is only in its infancy and is rarely applied on any effective scale.

The most common form of hazardous waste disposal is to treat hazardous materials and bury them in the ground, either in underground injection wells or in landfills. One form of treatment before land disposal is ***physical treatment*** where liquids are separated from solids through evaporation or filtration so that volume can be reduced. Paint containing toxic substances can be treated in this manner. Other toxic substances can be physically treated by concentrating them into a thick paste or mixing them in cement. ***Chemical treatment*** can be used to detoxify a harmful substance by adding chemicals that "neutralize" it. Adding lime to battery acid to decrease its acidity is one example of chemical treatment. At a special type of landfill called a secure landfill, toxic wastes which have been treated are enclosed in drums and secured in the ground between layers of clay to inhibit leakage of harmful materials.

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[3] *Ground Water*, Ohio EPA Public Interest Center, 1987, p. 5. Neither do the older sites have ground water monitoring wells.
[4] Ibid., pp. 22-23.
[5] *Great Lakes America*, US EPA, Region 5, 1982, p. 15.

In order for a landfill for solid or hazardous waste to be environmentally safe it must possess certain features. These include the following:

a. natural or synthetic liners to contain leachate;

b. gas venting and monitoring systems to control methane (natural gas), which is a highly volatile gas created at landfills by the natural process of organic decomposition;

c. monitoring systems to test for groundwater pollution;

d. specifications for types of waste the landfill is capable of handling safely and for those which should not be accepted.

Landfills can be a viable way to dispose of solid and hazardous wastes if they are properly designed, operated and monitored. The federal EPA (through the Resource Conservation and Recovery Act) has imposed strict guidelines to make them as safe as possible.

Although landfills can be made safe, the incineration of hazardous waste is emerging as a preferred method of disposal, because it greatly reduces the volume of wastes and the need to use scarce land space. (Landfill space will always be needed to some degree for ash remaining after incineration and for wastes that cannot be incinerated). Critics of incineration often identify the potential for air pollution from gases and particulate matter emitted after waste is burned. To cut down on air pollution, a variety of emission control devices can be installed at incinerators. Electrostatic precipitators are the most widely used.

Incineration is effective on some solid wastes and virtually all liquid organic wastes such as paint and solvents. Even PCB's can be incinerated at high temperatures. On the other hand, toxic metals such as lead and mercury cannot be incinerated. These require secure, lined landfills.

The best options for dealing with any type of waste are to reduce the quantity generated, reuse waste materials if possible, and to recycle as much waste as possible which cannot be reused. Recycling can be just as important for hazardous wastes as it is for household recyclables such as newspapers, glass and aluminum cans. Although recycling of hazardous waste can be expensive, when the costs of environmental impacts of various forms of disposal are considered, the net costs of recycling can be much less than first indicated.

Hazardous Waste Disposal and Legislation

Over 6 billion tons of hazardous waste are produced every year in the United States. That's more than one ton for every person in the country per year.[6] Given the potential for threats to human health through improper disposal of this waste, the creation of regulatory agencies and national legislation has been necessary. As part of its mission to safeguard the environment and human health, the ***U.S. Environmental Protection Agency (EPA)***, regulates hazardous waste and the disposal of hazardous wastes. Two pieces of legislation enable the EPA to fulfill this mission. The ***Resource Conservation and Recovery Act (RCRA)*** of 1976 establishes technical and safety standards for the generation, treatment, storage, transportation, and disposal of hazardous wastes. RCRA was amended in 1984 through the Hazardous and Solid Waste Amendments (HSWA). These amendments expanded EPA's authority, giving it responsibility to phase out the land disposal of hazardous waste and to induce industry to reduce the amount of waste it creates. Another important piece of legislation is the Comprehensive Environmental Response, Compensation, and Liability Act, known as ***Superfund***. Superfund allows EPA to clean up abandoned hazardous waste sites.

In 1972, Congress passed the ***Clean Water Act*** to restore and maintain the quality of the nation's water. The Ohio EPA's Division of Water Pollution and Control and the Division of Water Quality Monitoring and Assessment are responsible for carrying out the goals of the Clean Water Act. These divisions maintain close links with the Ohio EPA's Division of Solid and Hazardous Waste.

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[6] ***A Better Way: Guide to the RCRA Permitting Process***, U.S. EPA, Region 5, Chicago, Illinois, 1986, p. 1.

The Division of Solid and Hazardous Waste administers Ohio's solid waste and hazardous waste disposal programs. Some of the functions of this division include:

- Inspecting facilities that treat, store or dispose of hazardous waste;
- Technical reviews of hazardous waste disposal sites;
- Insuring that local health departments comply with the state minimum standards in their licensing and enforcement of solid waste disposal;
- Issuing Permit-To-Install (PTI) to all new solid waste facilities;
- Inspecting existing sanitary landfills and performing technical reviews of solid waste disposal sites;
- Helping locate solid waste disposal capacity for cities, counties and regional areas;
- Investigating complaints of illegal open burning and trash dumping

The Ohio EPA maintains an active, extensive network of employees all over the state who will speak to school classes upon request. They usually talk about the agency, what the agency does, what causes pollution, and how students can help. To request a speaker, contact the Ohio EPA Public Interest Center in Columbus, (614) 644-2160 or the Ohio EPA District office that serves your county.

Household Hazardous Waste and What To Do With It

As part of the background information to this chapter, two sections are presented below. One is a listing of common household hazardous wastes, classified according to type. The other is a guide to the disposal of household hazardous wastes reprinted from an Ohio EPA brochure. Another valuable disposal guide, which includes additional information, can be obtained from the Enterprise for Education, Inc. in California. The title of the guide is *Hazardous Waste From Homes*. It can be obtained for a small fee. Write to:

Enterprise for Education
1320-A Santa Monica Mill
Santa Monica, CA 90401

EXAMPLES OF HOUSEHOLD HAZARDOUS WASTES

Automobile:	motor oil, lubricating oil, brake fluid, automatic transmission fluid, battery, car wax, carburetor cleaner, antifreeze, gasoline
Painting & Woodworking:	enamel paint, varnish, latex paint, turpentine, paint thinner, glue, wood preservatives
Garden, Pet & Outdoor Supplies:	insecticide, herbicide, fungicide, snail and slug poison, flea powder
Household Cleaning Supplies:	rust remover, oven cleaner, drain opener, furniture polish, floor polish, metal polish, chlorine bleach, moth balls, tub and tile cleaners, disinfectant, toilet bowl cleaners
Personal & Health Items:	shoe polish, expired medical prescriptions, perfume and aftershave, nail polish, nail polish remover, rubbing alcohol, mercury (from broken thermometers)
Hobbies & Recreation:	gun cleaning solvent, photographic chemicals, artist oils and acrylics, ceramic glazes, swimming pool chemicals
Aerosol cans of all types.	

A GUIDE TO SAFE DISPOSAL OF HOUSEHOLD WASTES*

Acids/Alkalines

Acids (battery, hydrochloric) and alkalines (drain openers) burn the skin. The best way to get rid of acids or alkalines is to dilute them THOROUGHLY and wash them down the drain. An important safeguard when diluting is to ADD ACID TO WATER IN SMALL QUANTITIES AT A TIME. For example, add no more than an ounce of acid to a gallon of water, dump, and repeat this procedure until you have no acid left. Never add water to acid or it will splash and burn you.

Antifreeze

Small amounts of antifreeze (1 gallon or less) can be taken to your local wastewater treatment plant or else diluted thoroughly and washed down your drain. If you live in the country, pour antifreeze out along a fence row away from any wells. Animals are attracted to the sweet taste of antifreeze, so dispose of it where they won't be tempted. Also, make sure you spread antifreeze out as much as possible.

Arsenic/Cyanide

If you know where the substance came from (for example: if you brought it home from work) take it back. To dispose of small amounts, place the original container inside a larger plastic or cardboard container and fill the space in between the containers with lime. Put the container in the trash. Always avoid unnecessary handling. Contact Ohio EPA for information on what to do with large amounts of arsenic or cyanide.

Bleach

Bleach can be diluted and flushed down your sink drain. Never mix bleach with ammonia or with acidic products such as some drain, toilet bowl, and metal cleaners. Toxic fumes (strong enough to be fatal) will result.

Car Batteries

You can take old car batteries to a retailer. Check your yellow pages under "Batteries" for stores that sell batteries and take used batteries in exchange.

Cleaners/Polishes

Small amounts of cleaners and polishes (rug, floor, and oven cleaners; furniture polish) can be disposed of with the rest of your garbage.

Disinfectants

Disinfectants can be diluted and flushed down your sink. Disinfectants contain strong chemicals, so use them conservatively and with caution.

Gas Cylinders

Butane, propane, or other pressurized gas cylinders should not be disposed of with other refuse because of the serious explosion hazard. Contact your local refuse collector concerning disposal of the cylinders.

Gasoline

Gasoline is one of the most hazardous substances found around the home because it is poisonous and flammable. Try to find a way to use up leftover, uncontaminated gasoline. If you don't have a lawnmower, snowblower, or car that needs a little gas, try to find a neighbor who can use it.

Herbicides

Try to use up what you have, avoiding disposal whenever possible. Small amounts can be poured along a fence away from animals. The Ohio Department of Agriculture MAY accept small quantities of useable herbicides. Contact Ohio EPA for information on how to dispose of large quantities of herbicides.

Iodine

Iodine should be packaged in a tightly closed container (the original one if possible) and placed in another unbreakable container. Fill the space between the containers with cat litter, which will act as an absorbent if the inner container breaks. Dispose of the entire package in your trash.

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*Reprinted with permission from the Ohio EPA Public Interest Center, Columbus, OH (614) 644-2160.

Mercury

Mercury is highly toxic and can be absorbed through the skin. You should remember two important things: DON'T TOUCH MERCURY and DON'T THROW MERCURY IN THE GARBAGE. Your local high school laboratory may be interested in taking it. Otherwise, you should send mercury to a recycler. Contact Ohio EPA for a list of recyclers.

Paint

If the paint is still liquid, let it harden by taking the lid off the can. Once the paint solidifies, you can put it in the trash. If you have several cans of paint you want to get rid of, don't put them all in the trash at once; just put out one or two cans at a time. If the paint is still useable, donate it to a school or community organization in your area.

Pesticides

The Ohio Department of Agriculture accepts useable pesticides for redistribution. (Pesticides include insecticides and rodent poisons.) If the pesticide is old or unlabeled, small quantities (one pound/one gallon) should be securely packaged in several plastic bags and put in the trash. Contact Ohio EPA for information on what to do with large amounts of pesticides. Never dump leftover pesticides into soil or down drains, sewers, or septic tank systems. Also, never reuse pesticide containers. You should rinse the container three times, spray the rinse water on crops or your yard, then throw the container out with the other garbage.

Solvents

Small quantities of solvents (paint thinner, turpentine, varnish, stripper) should be securely packaged with cat litter and put in the trash. Do not dump onto soil, or down sewers, drains, or the toilet. Large amounts of solvents (more than 10 gallons) should be taken to a recycler. Contact Ohio EPA for a list of recyclers.

Used Motor Oil

Motor oil should be recycled. Contact the Ohio EPA to obtain information about the recycling center nearest you, or call a local service station and ask if they will accept your used oil. A convenient way to hold oil for recycling is to funnel it into an old plastic jug or gallon container.

Safety Measures

DO:
- Wear gloves and protective clothing to prevent skin contact.
- Handle the substance gently, especially if you don't know what it is.
- Thoroughly dilute any liquid you are going to wash down your drain.
- When disposing liquids, always put the original container into a second container and fill the space between with an absorbent.
- Keep toxic substances out of the reach of children and pets.
- Always read labels when you want to dispose of a product.
- Avoid unnecessary handling by transporting or disposing of materials in their original containers.

DON'T:
- Mix wastes together.
- Dispose of large quantities of any toxic substances in a septic system.
- Bury or burn containers or leftover substances.
- Collect various hazardous materials to dispose of at one time.
- Breathe fumes from toxic materials.

Alternatives to Toxic Substances

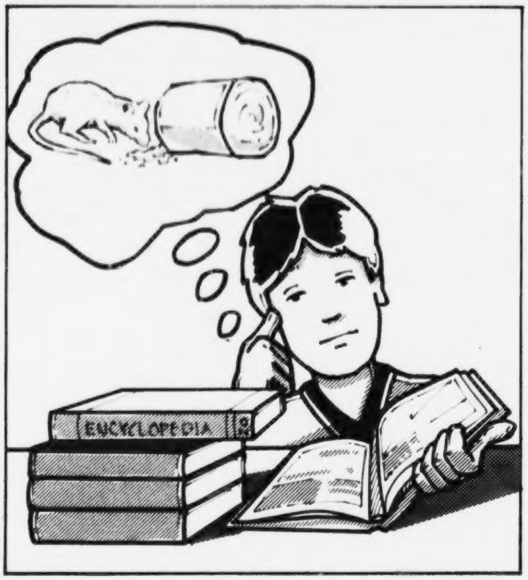
PRODUCTS	ALTERNATIVES
Drain Cleaners	Pour boiling water down the drain.
Paints and Solvents	Use water-based paint if possible.
Pesticides	Use "pest management." Keep your lawn and garden weed-free. Destroy infected plants.
Houseplant Insecticide	Put soapy water on leaves, then rinse.
Herbicides	Hand pull weeds or mulch generously. Cover garden with plastic in the fall to prevent weed germination.
Oven Cleaners	Use baking soda for scouring. For baked-on grease, put 1/4 cup ammonia in oven overnight to loosen, then scrub with baking soda.
Furniture Polish	Make a non-toxic polish by melting 1 tbsp. Carnauba Wax into 2 cups mineral oil. For lemon oil polish: dissolve 1 tsp. lemon oil into 1 pint mineral oil.
Silver Cleaner	Soak silver in 1 quart warm water with 1 tsp. baking soda, 1 tsp. salt, and a small piece of aluminum foil.

Ask For Help

Don't consider yourself an expert. Improper handling or disposal of hazardous wastes could be a serious threat to the environment and to you. Contact the proper authorities if you are not certain what to do.

SHABBY SHELTER

CHAPTER 8



PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *explain* how litter can provide a way for animals to meet their needs; (2) *describe* the harmful consequences to animals and to human health when animals make their homes in litter. Students will improve their abilities to find information and to *write creatively*.

Method

Students use sources of information to research the needs of animals and to *infer* how these animals could make homes out of various littered items designated on a handout. Negative consequences to animals and to human health are discussed, and plays or puppet shows are produced based on this information.

Duration: five to six class periods

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 4.1

Preparation

Collect resource information (encyclopedias, nature books, textbooks) about animal habitats, including how animals move and their requirements for breeding and shelter. You will also need materials to make costumes or puppets. It would be especially helpful, in regard to the creative writing exercises, if you could find one of the two books listed below to read to the class.

Bodecker, N.M. *The Mushroom Center Disaster*; Illus. Erik Blegvad. Atheneum, 1974.

Foote, Timothy. *The Great Ringtail Garbage Caper*; Illus. Normand Chartier. Houghton Mifflin, 1980.

Vocabulary

habitat, harmful, health, litter, shelter

Handouts

Litter Homes; Litter Attraction

Procedures

1. Briefly discuss unusual ways that animals might use litter: a straw used as a home by insects, or a snake living inside a discarded cooler. Do not mention items on the handout, ***Litter Homes***, for examples.

2. Distribute the handout, ***Litter Homes***, following your discussion. You may want to have students divide into groups of four or five to work on it. In order to complete the handout have students research insects and/or animals they think could make homes in the litter based on their requirements for shelter and/or food and/or reproduction. You may want to provide a list of insects and animals appropriate to consider: rats, roaches, flies, mosquitoes, snakes, etc. Reasons given by students on the handout might include statements like the following: "Roaches need a dark, damp environment so an old damp boot left out in the rain may serve as a home." "Mosquitoes like to breed in still water, such as water trapped in old tires." "Mice could find shelter from their predators in a boot." You may want to have students find examples of litter in addition to those on the handout and suggest what animals could make use of these and for what reasons.

3. Discuss answers to the handout from two viewpoints.
   a. How can these animals harm humans? Check to see which students' answers include rats, mosquitoes, flies, roaches, snakes and others that can clearly be harmful by spreading disease and/or biting and infecting people.

©1988 Ohio Department of Natural Resources; source: Celeste F. Geise, Ottoville Local School (Ottoville, Oh).

b. How can animals themselves be harmed by relying on these unnatural sources of shelter (e.g. Water could get trapped in a boot and drown small insects living there. Animals could inhale styrofoam and suffocate. They can ingest styrofoam and starve because their appetite becomes suppressed, yet they are without nourishment. Chemicals in tubes or circuits of TV could kill an animal. Glass breaks and cuts animals.)

4. Students should work in groups of four or five. Each group is to select one type of litter habitat from the handout. They are to write a script giving the point of view of the animal(s) living in that litter habitat. The script could include the animal's feelings about humans, why they have chosen this piece of litter as a home, etc. To give students an idea of possible scenarios you could read one of the books mentioned in the **Preparation** to students.
5. When scripts are written, the students can act out the play or they can present it as a puppet show.

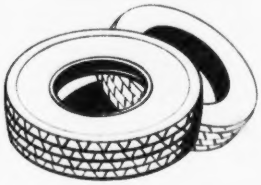
Evaluation

Ask students to write down the following claim: "Even though litter may provide homes for animals, natural homes for animals are better because litter can harm animals and it provides homes and nourishment for animals that cause harm to humans." Have students explain the claim orally or in writing. Give students the handout, ***Litter Attraction***, to complete. Have each student present his or her drawing to the class and post these on the bulletin board. In each case, ask students how the piece of litter was disposed of improperly and if the object could be recycled or not.

LITTER HOMES

Directions: Animals, both small and large, can make homes out of trash. For each item below name an animal that could use it for a home and explain why.

OLD TIRES

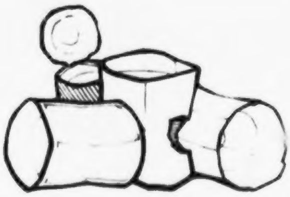


Animal: ______________________

Reason: ______________________

____

CANS: ALUMINUM OR METAL

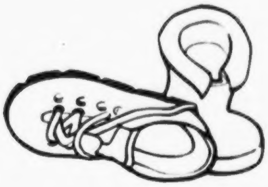


Animal: ______________________

Reason: ______________________

____

OLD BOOTS & SHOES

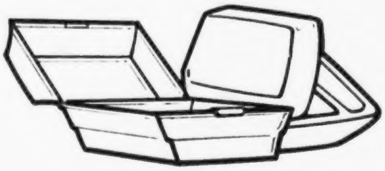


Animal: ______________________

Reason: ______________________

____

STYROFOAM CONTAINERS

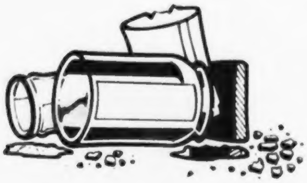


Animal: ______________________

Reason: ______________________

____

GLASS

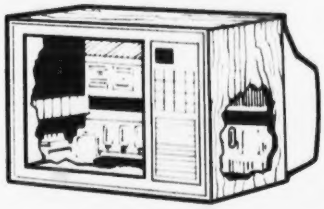


Animal: ______________________

Reason: ______________________

____

JUNKED TELEVISION



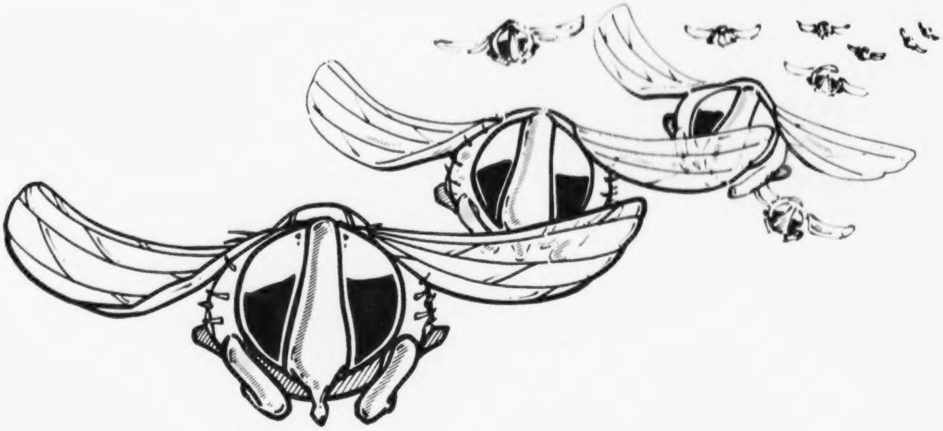
Animal: ______________________

Reason: ______________________

____

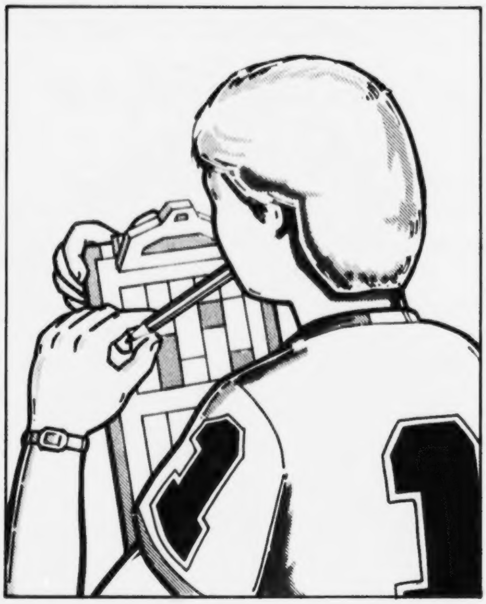
LITTER ATTRACTION

Directions: Draw the piece of litter that is attracting these flies.



LITTER REALLY HURT ME

CHAPTER 8



INTERMEDIATE

Objectives Students will be able to *describe* different ways that litter can harm people. Students will improve their abilities to *cooperate in groups*, to *collect data* and to *graph data*.

Method Students discuss and record different ways litter can be harmful. They *construct a survey* form and work in groups to decide who they will survey. After collecting surveys they organize data, they *figure percentages* and they express results in a graph.

Duration: five class periods

Setting: classroom, community

Subjects: Social Studies, Mathematics

Curriculum Reference: 4.1

Preparation Have pictures of litter available. If possible, find pictures of people injured by litter to show to class.

Vocabulary accident, data, graph, litter, percentage, survey

Handouts ***Litter Accident Survey Form; Litter Accident Data; Data Presentation***

Procedures

1. In a class discussion, define litter and relate it to accidents. List examples from students' experiences of accidents caused by litter.
2. Divide the class into small groups and allow students to devise a survey for types of accidents caused by different kinds of litter. You may wish to use the sample handout provided, ***Litter Accident Survey Form***. On this form each group adds two extra examples discussed in class. Students in each group decide to whom they want to give their survey: to parents and relatives, to neighborhood residents, etc. Each group should try to have 25 or more respondents targeted. If giving the survey to neighborhood residents, you may want each group to define a specific territory so residents do not receive more than one form. MAKE SURE TO CONSTRUCT A COVER LETTER TO APPEND TO THE SURVEY DESCRIBING THE SURVEY TO PARENTS OR COMMUNITY MEMBERS.
3. Allow several days for completion of the assignment.
4. Have each group record their data. Use the handout, ***Litter Accident Data***, for this procedure. There is room for groups to add the two extra questions they put on the survey form.
5. After students have calculated percentages in the ***Litter Accident Data*** handout, have groups present their data in graph form with percentages indicated by making a bar graph using the ***Data Presentation*** handout. Display and discuss results.
6. Discuss ways that communities can prevent accidents caused by litter.

Evaluation Post the survey material (the ***Litter Accident Survey*** form and the ***Data Presentation*** handout) from each group in various stations throughout the room. Have each student write down the following questions and give answers based on their analysis of each group's data.

1. Which type of accident is the most frequently recorded in all groups together?

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2. For each category, add up the total number of tallies from all groups. Figure what percentage of the total number of all accidents from all groups each category represents.

LITTER ACCIDENT SURVEY FORM

1. Have you ever been hurt by a sharp, rusty object left as litter? Describe briefly.

2. Have you ever been harmed or made sick by a dangerous substance left as litter? Describe briefly.

3. ______________________________.

   Describe briefly.

4. ______________________________.

   Describe briefly.

A. If you have ever had to receive medical attention from a doctor or hospital for any of these accidents, please describe on back.

B. Have you been hurt by litter in a manner not described above? If so, put on back as well.

LITTER ACCIDENT DATA

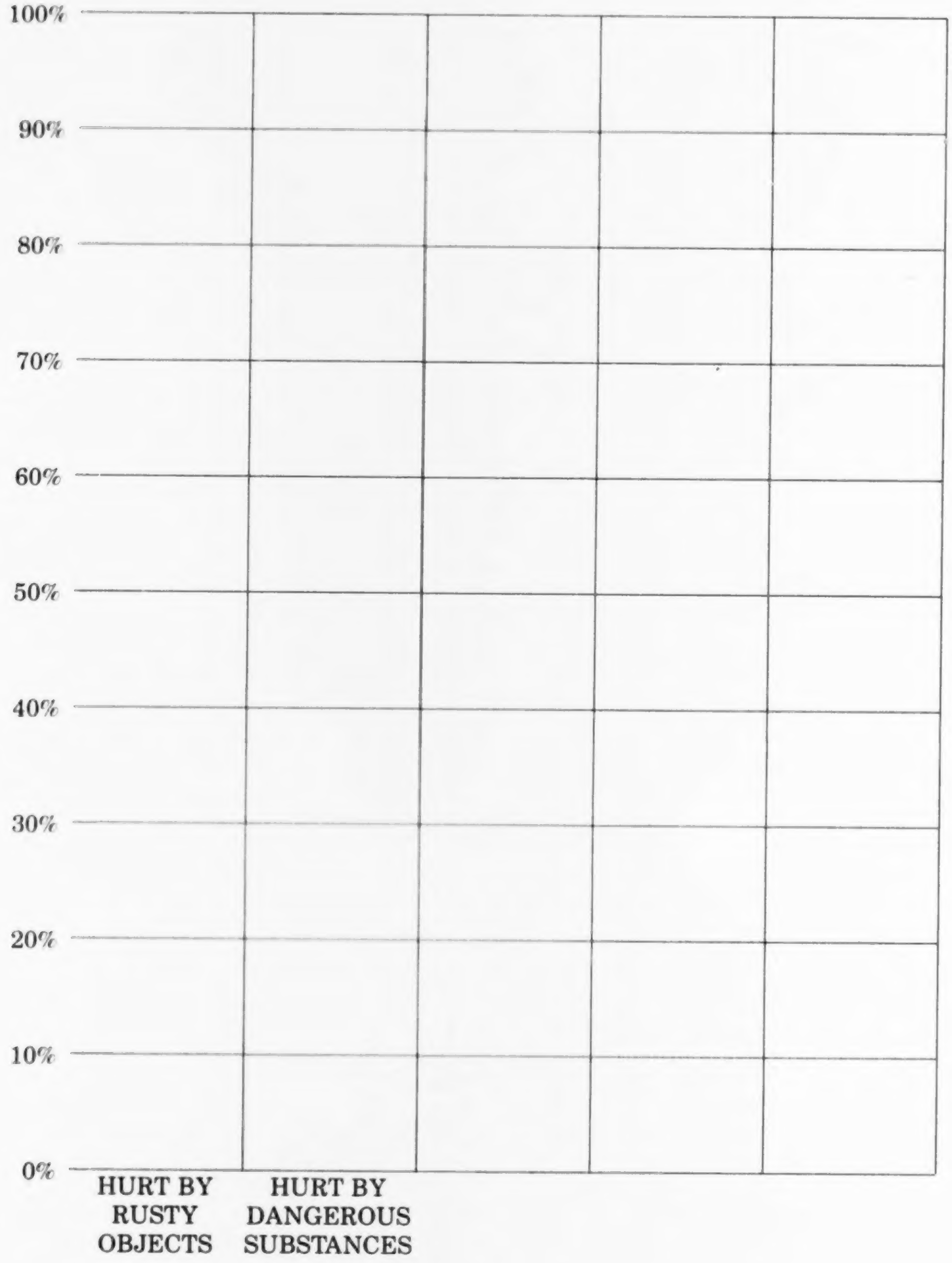
Directions: Make a check mark for each recorded instance in the TALLIES space. After recording all tallies, add up the total and enter in the TOTAL column. Figure what percentage of the total number of accidents each accident description represents by dividing the total number of tallies for all accidents by the total for each accident.

Number of People Surveyed = _______

ACCIDENT DESCRIPTION	TALLIES	TOTAL	PERCENTAGES
1. Have you ever been hurt by sharp, rusty objects left as litter?			
2. Have you ever been hurt by dangerous substances left as litter?			
3.			
4.			
5. Other examples			
	TOTAL NUMBER OF ALL ACCIDENTS		

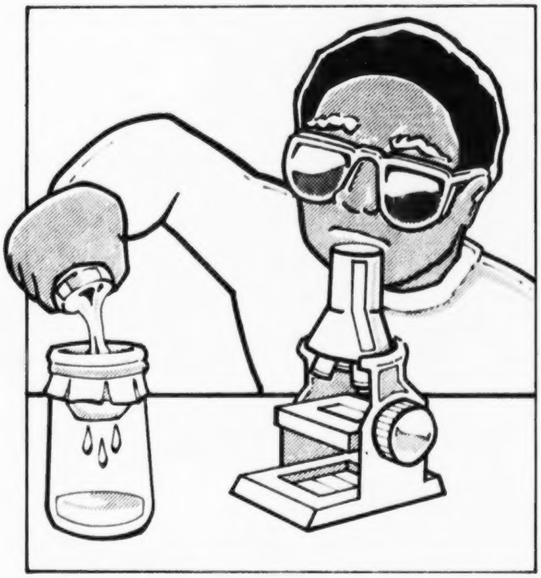
Show how you have figured percentages for 1-5 below.

#1 #2 #3 #4 #5


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
HURT BY RUSTY OBJECTS
HURT BY DANGEROUS SUBSTANCES

IS THE WATER FIT TO DRINK?

CHAPTER 8



INTERMEDIATE

Objectives

Students will be able to: (1) *explain* why water for drinking must be filtered; (2) *describe* how clean looking water may actually be polluted. Students will improve their abilities to *make comparative observations* and to *manipulate equipment* useful in experiments.

Method

Students *cooperate in groups* to conduct an investigation of two polluted water samples and a sample of clean water. They use microscopes and record their observations. They filter the polluted water samples and once again record their observations.

Duration: five to six class periods

Setting: classroom

Subject: Science

Curriculum Reference: 4.2

Preparation

Gather one large bucket of water from a stream or lake which appears polluted. Make another bucket of water polluted with litter from the classroom; let it sit for 5-7 days before beginning the activity. This may include any tiny items from the waste basket: small pieces of paper from the floor, sweepings from classroom floor, scrapings from bottom of shoes, tiny particles from bottom of a desk, organic food items such as gum, candy, food crumbs, etc. You will also need a third container of non-polluted tap water. Each group of three students should have a microscope, two microscope slides, two cover glasses and an eye dropper. Also, each group needs two clear glass one-quart wide-mouthed mayonnaise jars, a coffee filter, a rubber band and two baby food jars. The teacher should be ready to explain the correct use of the microscope, slides and cover glass. Paper and pencil will be needed by each student.

Vocabulary

filter, pollution, purify, sample, waterway

Handout

Filtering Water

Procedures

PART I

1. Each group should prepare a slide of a drop of non-polluted tap water. Have students use this slide in the microscope to observe the non-polluted water. Each student in the group should draw on a piece of paper what they have observed. Label this picture "non-polluted water."
2. Each group should prepare a slide of a drop of classroom polluted water and observe it under the microscope. Once again each student should draw on a piece of paper what they observe and label this "classroom polluted water."
3. Repeat the same procedure with the polluted lake or stream water, labeling this sample "polluted waterway water."
4. Have students compare their three pictures. Which water is the most polluted and which the least? Why? Talk with the class about pollution and litter.

PART II

1. Make note that much of our drinking water comes from streams and lakes or from underground wells that can often be polluted by material which students have observed in their pollution samples. Discuss how the pollution could get into the water. Ask students what might be in the waterway polluted water sample that could be dangerous to human health. Discuss how hazardous materials can find their

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©1988 Ohio Department of Natural Resources; source: Bruce Averell, Silver Lake Elementary, (Cuyahoga Falls, Oh), and John R. Larabee, East Elementary, (Lancaster, Oh).

way into drinking water sources. Ask students how the pollution in the two polluted samples might be removed.

2. Have students work in small groups again. Pass out a mayonnaise jar, coffee filter, rubber band and two baby food jars to each group. Demonstrate the method for attaching filter paper to the mouth of the mayonnaise jar by folding the edges of the filter over the lip of the jar and securing it with a rubber band on the outside of the lip. Ask the students to get a sample of littered water from the "classroom polluted water" using the baby food jar.
3. Direct a member of each group to pour the water *a little at a time* (so as not to damage filter) into the filter while everyone observes the results. Have students describe what is left in the filter.
4. Repeat the procedure with the "polluted waterway water" sample.
5. Have the students make slides of the two water samples that have just been filtered and compare with slides of the original tap water. Identifiable matter should still show up under the microscope in all three slides.
6. Explore these observations by having students complete the handout, ***Filtering Water***. Discuss. Question #4 on the handout is particularly important. Step 7 below is a follow-up to this question.
7. Have students research different reasons why water may not be fit to drink even though it looks clean, and why some water may look dirty or polluted and not be as harmful as cleaner looking water. Important issues in this regard include the following:
   - Water may contain toxic dissolved chemicals or substances (that may not be visible under a microscope).
   - Water may contain disease producing organisms such as bacteria, which are often visible, or viruses, not visible even under a microscope.
   - Water may contain something that looks and smells bad but is not really "harmful."

Evaluation

Have each student identify five substances which can pollute our waterways and explain in each case how the pollution could have gotten in the water.

FILTERING WATER

Directions: After you have observed the filtering process, answer the following questions to the best of your ability.

1. Write a brief description about what you observed when the water from the two polluted samples was drained into the bottom of the filtering jars.

2. Based on the type of matter you have observed in the filter, why is it important to filter water?

3. If you still saw particles of matter in the "filtered" water under the microscope, explain how this happened.

4. On the back, explain why water which looks clear may still not be fit to drink.

POLLUTION AROUND THE WORLD

SAVE THE EARTH

INTERMEDIATE

Objectives

Students will be able to: (1) identify sources of pollution in the U.S. and around the world; (2) *classify* different types of pollution; (3) *describe* the harmful effects of different types of pollution. Students will improve their abilities to *lead discussion* and to *write creatively*.

Method

Students gather information from newspaper and/or magazine articles. They display and lead a discussion about the information. They find where their articles are about on a world map. They *infer* the effect of pollution by writing an article as if they were individuals involved in a pollution event.

Duration: ongoing during a month or more, requiring one or two class periods on selected days

Setting: classroom

Subjects: Science, Social Studies, Language Arts

Curriculum Reference: 4.1, 5.4

Preparation

one large world map, one large U.S. map, yarn; articles from sources of current information such as newspapers or magazines from home; bulletin board, paper to mount articles, glue or tape

Vocabulary

country, location, pollution

Handout

Subject-Predicate Pollution Statements

Procedures

1. Use the following current event activity on selected days to begin a science lesson. Put the caption, "Where is Pollution?" on the bulletin board above a world map and a U.S. map. Do the first example to show students what you expect: Find an article in the newspaper that pertains to some form of pollution and cut it out. Mount it on a small piece of construction paper. After reading the article, discuss with students the form of pollution and the effects it had and may have in the future on plants, animals and/or people. After the discussion put the article on the bulletin board with yarn going from the article to the state or country discussed in it.

2. Have students complete the ***Subject-Predicate Pollution Statements*** handout to give them an idea of types of pollution they can look for in the press. Discuss all types of pollution. Now have students find their own articles and display them. As students bring in their articles, encourage them to read these aloud and lead a class discussion. Some students may not get the newspaper, so it is a good idea to bring one in each day for students to search through during their free time.

3. When you have a day when NO form of pollution hits the headlines, APPLAUD!

4. To reinforce the idea that there are many types of pollution and pollution behaviors, have students look at each article (may want to give each article a number) and decide what type of pollution is described. Sample categories: a. litter, b. solid waste from consumers, c. solid waste from business or industry, d. solid waste that became hazardous through incineration or dumping, e. hazardous waste (liquid, solid or gas) that was not properly contained, f. chemicals used to protect crops or plants, g. chemicals used to fight insects or parasites and h. other.

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Evaluation Have students assume the hypothetical role of a person actually involved in one of the events posted on the bulletin board. They could write an article for the local newspaper about what happened to them in the situation described in the article they chose.

SUBJECT-PREDICATE POLLUTION STATEMENTS

Directions: Underline the complete subject once, and the complete predicate twice.

1. Polluted water can harm animals and people.

2. Pesticides and herbicides can damage soil.*

3. A big oil tanker may spill a huge load of oil into the sea.

4. A toxic spill from an overturned truck may force people from their homes.**

5. The fish were killed by toxic metals which ran into the water.

6. The average American throws away more than 252,000 pounds of garbage in a lifetime.

7. The Environmental Protection Agency estimates that there are over eighty thousand dumps with toxic waste in the United States.

8. Litter can harm plants and animals.

9. Waste products from power plants can be dangerous.

10. The fifth grade students helped pick up litter on the playground.

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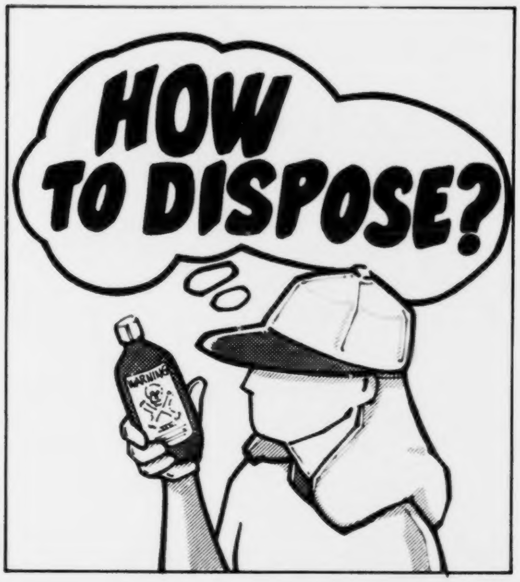
* Look up the definition of the words "pesticide" and "herbicide."

** Look up the definition of the word "toxic."

HAZARDS AND WASTE

CHAPTER 8



INTERMEDIATE

Objectives

Students will be able to: (1) *describe* what makes some household products hazardous; (2) explain the importance of warning labels on products; (3) *classify* household hazardous products by use; (4) identify methods of disposing of household hazardous products and containers when no longer needed and *explain* how improper disposal can pollute the environment and water supply. Students will improve their ability to *make inferences.*

Method

Students make adjectives out of nouns and verbs to describe the characteristics of household hazardous products. They identify hazardous products in their homes and read labels with the help of adults in order to classify household hazardous products. Students make inferences from an illustrated map to answer questions about the effects hazardous product disposal can have on the environment. They create their own labels for hazardous products.

Duration: five to six class periods

Setting: classroom, home

Subjects: Science, Language Arts

Curriculum Reference: 4.1, 4.2

Preparation

writing materials, dictionaries; some samples of household hazardous waste products with warning labels (Find an item from each household category identified in the Background Information, p. 200)

Vocabulary

aquifer, brand name, corrosive, environment, generic name, hazardous, household, ignitable, incinerator, open dump, pollution, reactive, sewage treatment plant, synonym, toxic, warning, water purification facility

Handouts

Describing Harmful Waste; Identifying Household Hazardous Products; Hazardous Waste Disposal Routes; Warning Labels

Procedures

1. Have students complete the handout, ***Describing Harmful Waste***, to become familiar with the traits of hazardous products which often become part of the waste stream.

2. After completing the handout explain the following descriptions of hazardous waste to students. You may wish to write these on the board.

   a. Hazardous waste poses a danger to human health and to the environment because of one or more of the following characteristics which a hazardous substance may possess. It may be:

      ignitable
      corrosive
      reactive
      toxic

   b. A hazardous waste may take the form of a solid, a semi-solid, a liquid or a gas.

   c. Many items that we throw away in our homes contain hazardous substances. We call them *household hazardous waste.*

3. Refer to the list of household hazardous products in the Background Information of this chapter, p. 200. Find a sample item from each "household category" to bring in to class to discuss with students. Try to find products with warning labels. But, be aware, the hazardous nature of many household hazardous products is unknown, or not clearly identified or not often discussed on the warning label. Some products will say "flammable" or "ignitable" on the label when they are actually "reactive" and per-

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haps even "toxic" as well. Many plastics are ignitable and some are also toxic when burned if they are not burned at very high temperatures, but there are usually no warnings to this effect on plastic products. Even a material as seemingly harmless as newspaper possesses the potentially hazardous characteristics of being ignitable.

4. Read the warning labels from the items you have brought in and discuss the hazardous characteristics according to the four descriptions already discussed in class. Point out possible hazards the product may possess but which are not mentioned on the label. Finally, identify the category of household waste each product represents and where it may be found in a home. You could list the categories on the board and have students discuss which categories the products represent.

5. As a homework assignment give each student the chart handout, ***Identifying Household Hazardous Products***, to complete at home. *IMPORTANT NOTE:* MAKE SURE YOU SEND THIS CHART HOME WITH A COVER LETTER TO PARENTS OR GUARDIANS EXPLAINING THAT THEY SHOULD HELP THE STUDENT WITH THIS ASSIGNMENT. Go over directions with students so they will understand what is expected. Explain what *generic* means and also mention that the descriptions of hazardous characteristics on labels of products may include words other than the four discussed in class. Students, with the help of an adult, should try to interpret the warnings according to the four traits discussed in class. This could lead to a lesson on synonyms.

6. Discuss the completed charts with students. Make a four category list of synonyms or other descriptions that have the same or similar meanings to the four descriptions of hazardous materials discussed in class.

7. After discussing the completed charts with students, draw their attention to another very important area of concern not shown on the chart, but which would make an important fourth column on the chart. Ask them what this might be. ("HOW TO DISPOSE") Have students complete the handout, ***Hazardous Waste Disposal Routes***. Before they begin, explain the following items on the handout:

   a. Aquifer - an underground source of water.

   b. Landfill - a place where waste is covered with earth each day, and before the landfill is used, a liner (of clay or plastic) is put deep underground so that waste materials mixing with rain and other waste liquids do not leach into the ground (and hence into water supplies or aquifers - do not mention this consequence to students before they begin on the handout). However, if this harmful liquid, called leachate, is not drained properly, or if the liner does not contain liquid efficiently, harmful liquids may leach into the ground. Some older landfills do not contain liners.

   c. Trash incinerator - a place where waste materials are burned in a furnace; smoke and ash residues are created.

   d. Sewage treatment plant - a place where waste water from toilets and sinks goes to be filtered and cleaned so the waste water can be returned to the environment, in this case a river.

   e. Water purification facility - a place where water is cleaned before it is piped into homes; on the map, the water being cleaned and used for drinking by the people living in the apartment is river water.

   f. Draw students' attention to the *yard* and *gutter* as places where hazardous household products may be thrown away by people that are not thinking about the environmental effects of their actions.

8. Have students look at their charts (***Identifying Household Hazardous Products*** handout) and decide what would be the best way to dispose of the items they have listed from home. Refer to Background Information p. 201. (You may want to copy this material for the students to use.) Students could work in groups to complete this assignment. Explain that some hazardous products (motor oil, car batteries and other items) can be recycled. Explain why recycling could be the best alternative to any type of disposal of hazardous products.

Evaluation Give each student the handout, ***Warning Labels***, to complete. Have each student make a sentence for each of the five adjectives listed in Question #6 on the handout, ***Describing Harmful Waste***.

DESCRIBING HARMFUL WASTE

Directions: Fill in the blanks below. Use a dictionary to help you choose from answers given at the end of this exercise. Write out the answers in each blank. This is a lesson about adjectives that can be made from nouns and verbs by changing their endings.

1. The word *hazard* is a ________________
(part of speech)

meaning ________________ .
(definition)

The ending ________ will make hazard into an adjective

meaning ________________ .

2. The word *react* is a ________________
(part of speech)

meaning ________________ .
(definition)

The ending ________ will make react into an adjective

meaning ________________ .

The adjective form of the word react is ________________ .

3. The word *ignite* is a ________________
(part of speech)

meaning ________________ .
(definiton)

The ending ________ will make ignite into an adjective

meaning ________________ .

To make the adjective form of the word ignite you must drop the letter ____ and add

________ to make the word ________________ .

DESCRIBING HARMFUL WASTE (cont.)

4. The word *corrode* is a ______________________________
(part of speech)

meaning ____ .
(definition)

The ending ______________ will make corrode into an adjective

meaning ____ .

To make the adjective form of the word corrode you must drop the letters ______ and

______ and add ____________ to make the word __________________________ .

5. The word *toxin* is a ______________________________
(part of speech)

meaning ____ .
(definition)

The ending ______________ will make toxin into an adjective

meaning ____ .

To make the adjective form of the word toxin, you must drop the suffix ______ and add the

suffix ____________ to make the word __________________________ .

6. Write all five words in italics above in their adjective form:

1. ______________________________ 2. ______________________________

3. ______________________________ 4. ______________________________

5. ______________________________

ANSWERS:

PARTS OF SPEECH: noun or verb

DEFINITIONS ARE:
a. to catch on fire
b. a danger
c. something that can cause death (poison)
d. to explode
e. to wear away

ADJECTIVE ENDINGS (which are also SUFFIXES) ARE:
a. ic
b. able
c. ive
d. ous

ADJECTIVE MEANINGS ARE:
a. able to catch on fire
b. dangerous
c. able to cause death (poisonous)
d. capable of exploding
e. can wear away

INDENTIFYING HOUSEHOLD HAZARDOUS PRODUCTS

Directions: Fill out the chart below by finding one example of a household hazardous product for each type of product already listed. *Have a responsible adult help you describe the waste item and to identify hazardous characteristics of the product.* If you can, think of an additional "TYPE" of hazardous product and find an example to describe on the last line.

WASTE ITEMS: give generic description, not brand name of product	HOUSEHOLD TYPE	PHYSICAL STATE	HAZARDOUS CHARACTERISTIC(S)
	AUTOMOTIVE		
	PAINTING and WOODWORKING		
	GARDEN and LAWN SUPPLIES		
	HOUSEHOLD CLEANING		
	PERSONAL HEALTH		
	HOBBIES and RECREATION		

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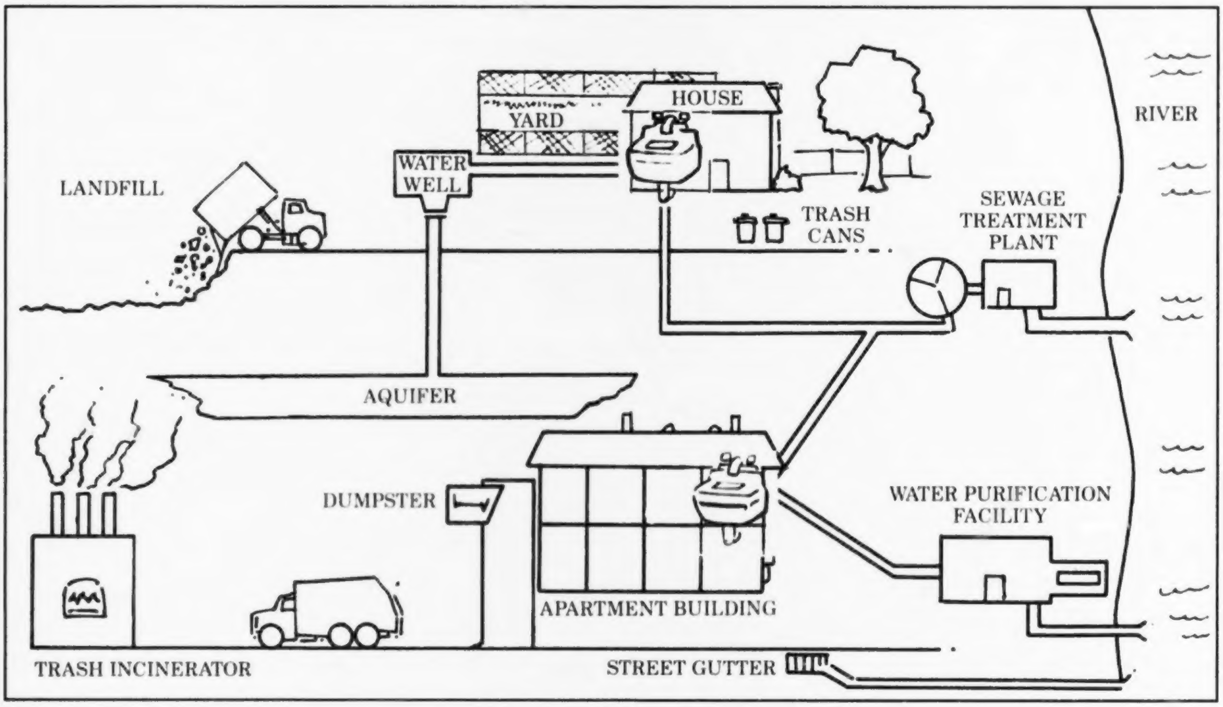
HAZARDOUS WASTE DISPOSAL ROUTES

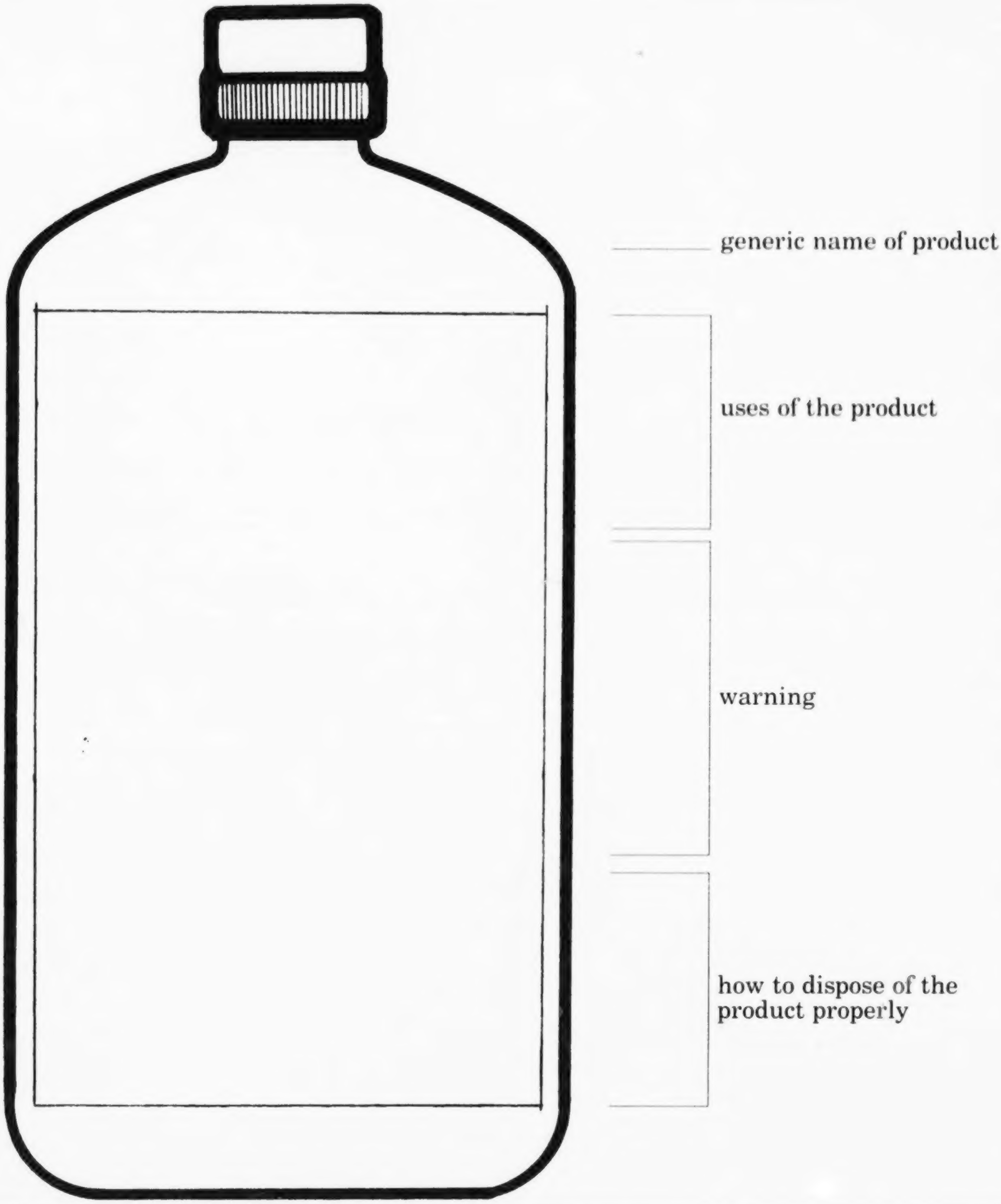

YARD
HOUSE
RIVER
WATER WELL
LANDFILL
TRASH CANS
SEWAGE TREATMENT PLANT
AQUIFER
DUMPSTER
WATER PURIFICATION FACILITY
APARTMENT BUILDING
TRASH INCINERATOR
STREET GUTTER

Directions: Look at the diagram above to help you answer the questions below. Answer questions on a separate sheet of paper.

1. Name two places where waste materials, including household hazardous waste, are often taken when you throw them away in your trash can or dumpster.
2. What can happen to the environment if wastes are not disposed of properly in these two places? How can waste be disposed of properly in these two places so that pollution is contained?
3. Name two ways that the river in the diagram could become polluted by household hazardous waste.
4. Many people get their drinking water from underground aquifers. Describe two ways an aquifer could become polluted. What affect might this have on people living in the house in the diagram?
5. Many people get their drinking water from rivers. Describe how polluted water could get into the drinking water at the apartment.

WARNING LABELS

Directions: Make up a fictitious household hazardous waste product with a label. Write information on the label space of the container based on directions given beside the container.



generic name of product

uses of the product

warning

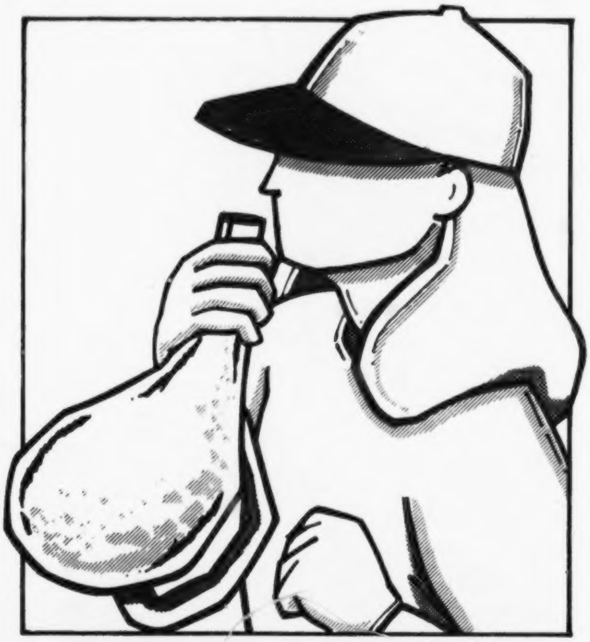
how to dispose of the product properly

Chapter 9

Waste Age Choices

THE WRAP UP

CHAPTER 9



PRIMARY

Objectives

Students will be able to: (1) *identify* products and packaging used in the past and products and packaging used in the present; (2) *explain* why littering has increased in modern times. Students will improve their ability to *make comparisons*.

Method

Students use a handout with pictures to identify types of packaging used by early Americans and packaging used by modern Americans. They discuss reasons why we have more waste and litter now than people did in the past. Students *draw* pictures and *write* answers to questions about litter problems.

Duration: four to five class periods

Setting: classroom

Subjects: Social Studies, Language Arts, Art

Curriculum Reference: 8.1

Preparation

Identify and develop an understanding of THEN and NOW Americans. Share books and audiovisuals about early Americans. Have chart paper available for each team.

Vocabulary

litter, now, packaging, then

Handouts

Then and Now Packaging, Picnic Past, Then and Now Test

Procedures

1. Have each student complete the handout, ***Then and Now Packaging***, and go over it.
2. Arrange to have groups bring in items, pictures or drawings on both THEN and NOW packaging. Discuss what they have brought in. (THEN things used for packaging were often reuseable; NOW things used for packaging are often throw-aways.)
3. List the following items on the board: a. metal plates (tin, pewter); b. metal knives and forks; c. cloth napkins; d. water (or lemonade) bottles; e. pottery crock of baked beans; f. wooden picnic basket; g. unwrapped loaf of bread; h. cheese in wax casing (or wrapped in cloth); i. blanket. Tell students these are items which would have been taken on a picnic 100 years ago. (You might want to list other items in place of some listed here, but use only nine items). Have students write this list in the spaces on the left hand side of the handout, ***Picnic Past***. Ask students what would be taken on a picnic today and how the items would differ from each item on the historical list. For example, *paper or plastic* instead of metal plates, *soda pop cans* instead of water bottles, *can* instead of crock of baked beans, *table* instead of blanket for ground, *cooler* instead of basket or in addition to it, *paper* napkins or *paper* towels instead of cloth napkins. Have students write the modern item in the spaces to the right on the handout. Discuss with students the two pictures at the bottom of the page. How are they different (one on right has more litter and a car instead of horse and buggy). Ask students why modern picnickers use more items which tend to be littered than did people in the past. Rely on items listed above the pictures to aid discussion.
4. Have students discuss why NOW waste and litter are more of a problem than THEN waste and litter. (THEN products represented small investments and with care could be reused indefinitely. NOW items such as paper plates, disposable diapers, etc. cannot be made sanitary

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©1988 Ohio Department of Natural Resources; source: E. Joan Parkey, Smith Middle School (Vandalia, Oh) and Rosalie Spencer, East Elementary (East Liverpool, Oh) and Marilee King, Olive Hill Elementary (Trotwood, Oh).†

again for reuse. We therefore have more waste to dispose of today, which means more scarce land is required to bury waste, *unless* we recycle and use more recycable products.)

5. On the board create a chart. Have students make sentences for the chart. You might write in the subject *or* the predicate for various statements and have them supply the missing subject or predicate. Example of chart:

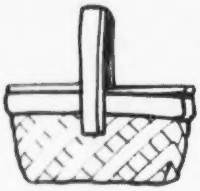
SUBJECT	PREDICATE
Litter	makes the environment ugly
Americans today	use a lot of packaging

Evaluation

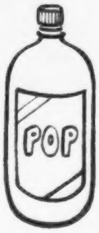
Give students the ***Then and Now Test*** handout to complete and go over answers.

THEN AND NOW PACKAGING

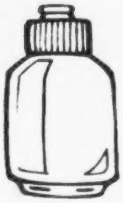
Directions: Draw a circle around the type of packaging the THEN Americans used.



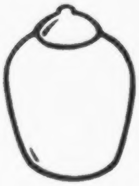
wicker basket



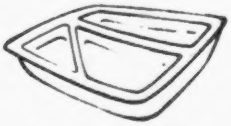
plastic pop bottle



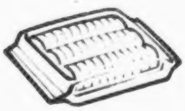
glass cookie jar



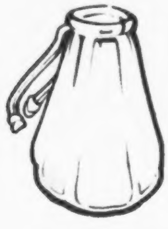
pottery crock



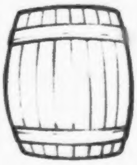
aluminum tray



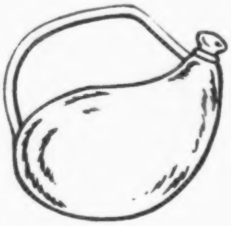
plastic wrap



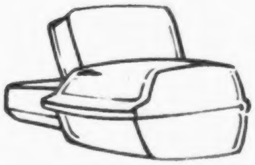
animal skin



wooden barrel



cloth bag

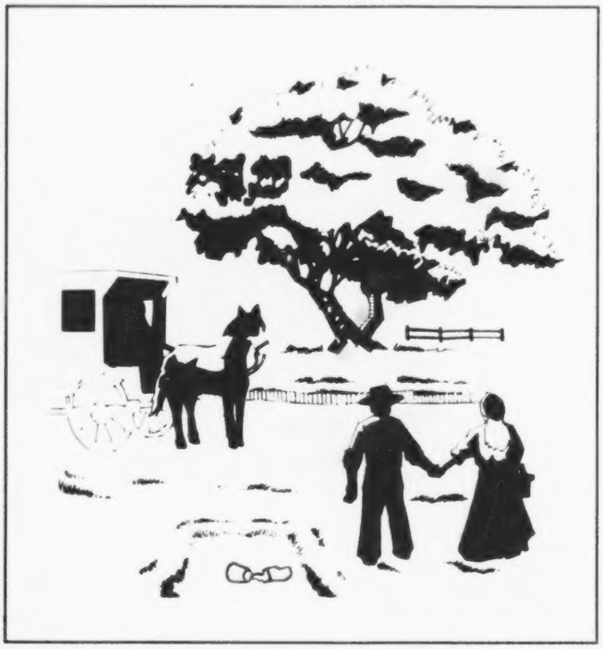


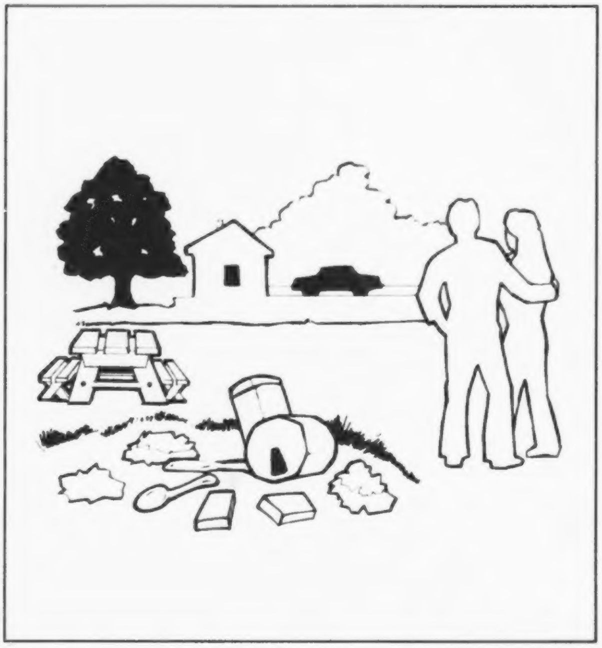
styrofoam container

PICNIC PAST

Directions: Write answers in the column to the right after the teacher gives you a list of items to write in the left hand column.

	ITEMS FOR A PICNIC 100 YEARS AGO		ITEMS USED INSTEAD AT A PICNIC TODAY
a.		→	
b.		→	
c.		→	
d.		→	
e.		→	
f.		→	
g.		→	
h.		→	
i.		→	





THEN AND NOW TEST

1. Draw two pictures of packaging materials used by THEN Americans. Label each picture.

2. Draw two pictures of packaging materials used by NOW Americans. Label each picture.

3. Why is there more litter NOW than THEN? ____________________

____

____

____

4. How can we solve the NOW litter problems? ____________________

____

____

____

TO BUY OR NOT TO BUY

CHAPTER 9

.AR DAYS
4
SOUP · CEREAL
CANNED GOODS
· JELLO ·
SHOP WISELY TO SAVE RESOURCES
SALE

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *classify* different types of packaging based on recyclability; (2) *describe* different reasons why products are packaged; (3) *identify* excess packaging that is unnecessary; (4) *make choices* based on a consideration of the environmental impact of actions. Students will improve their ability to *make consumer decisions.*

Method

Students observe and classify a variety of packaging brought from home. They *identify alternatives* to consuming and producing unnecessary or wasteful packaging. They discuss and *write* creative ideas for commercials that may be produced in class.

Duration: six to eight class periods

Setting: classroom, home

Subjects: Social Studies, Language Arts

Curriculum Reference: 6.1

Preparation

For Step 2: nut shell, orange peel, banana peel; clay pot, paper grocery sack, glass bottle; plastic bubble packaging from a toy, plastic milk container and styrofoam packaging.

For Step 5: a toy without packaging, identical toy with packaging.

For Evaluation Exercise: sock in a plastic bag, glass bottle, cereal in a box with "made from recycled paper" symbol on it, large can of pork and beans.

Vocabulary

biodegradable, necessary, packaging, recyclable, unnecessary

Handout

Making Wise Decisions

Procedures

1. Give students pre-test handout, ***Making Wise Decisions***. Collect after they have completed it to the best of their knowledge.
2. Tell the students that there are three types of packaging. Present them with examples of three types of packaging:
    a. a nut shell, an orange peel and a banana peel as packaging in nature;
    b. a clay pot, a paper grocery sack, and a glass bottle as examples of reusable and recyclable packaging (discuss the meaning of reuse and recycling);
    c. a plastic bubble used in packaging a toy, plastic milk container and styrofoam packing pieces as examples of packaging that are hard to recycle.
3. Announce that for the next week the students will be saving types of packaging to bring to school for further activities. Tell each student to place an empty grocery bag in the kitchen. As soon as Mom or Dad returns from the grocery store or department store, the student should help them unpack the goods and save the clean packaging to bring to school.
4. Divide the students into small groups of five or six and have them classify the packaging they brought to school into the three groups discussed in class. (i.e. packaging from nature; reuseable or recyclable; hard to recycle.) Note and discuss which group had the most packaging. You may want to weigh each group's collection and compare.
5. Use the above activity as a springboard to discuss the following:
    a. Much of the waste materials each household

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throws away is packaging. (Refer to the packaging brought in by the students.)

b. This packaging represents energy and natural resources because energy and natural resources are used to make the packaging. Have students identify the type of natural resources used to make the packaging (i.e. paper from trees, plastic from petroleum, glass from sand).

c. Some packaging is necessary for the purpose of keeping things clean to protect our health (e.g. sterile bandages), to preserve what is inside the package (e.g. food in sealed glass jars), to tell you what the product is or how to use it. (You could use examples from packaging the students brought in.)

d. Point out that other types of packaging can be unnecessary. Present a toy without the packaging and an identical toy attractively packaged inside a bubble of plastic on cardboard. Have them vote for the one they think most people or children would choose to buy. Ask students why toys are packaged as they are, even though the packaging may be unnecessary.

6. In order to be wise consumers of goods and in order to save energy and natural resources, people need to think about the packaging of goods before they buy them. Have students make a list of recommendations. Compare with the following suggestions after they have already brainstormed their own recommendations.

   a. Don't buy things with unnecessary packaging. Buy unpackaged items whenever possible. (Don't buy toys in plastic bubbles with cardboard around them. Buy shirts on hangers instead of in plastic bags. Don't buy fruit wrapped in plastic.)

   b. Buy containers that can be refilled or recycled. (Returnable glass pop bottles and cans and only plastic items which can be recycled.)

   c. If products must be packaged, look for packages made from recycled materials. Look for a recycling symbol on the product. (NOTE: Many packaging materials and products are made from recycled materials but do not include a recycling symbol.)

   d. Buy a large package of a product instead of many small packages. Then there will only be one package to waste or recycle instead of many small packages. Big packages of items usually cost less, too.

   e. If products are packaged, buy ones that have a package that could be reused.

7. Have students develop TV or radio commercials about unnecessary packaging and use of recyclable packaging. These could be put on videotape if equipment is available. Have students emphasize conservation values associated with saving resources and scarce landfill space. They could bring in magazines and newspaper advertisements. Discuss the fact and opinion approach to packaging and advertising: packaging that is necessary based on factual claims (i.e. freshness) and packaging that is unnecessary based on opinion (i.e. "exciting" tag). Find a good example of each. Write and share some original advertising techniques which could be used to sell products based on their recyclability.

Evaluation

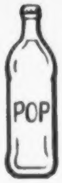
1. Present the following goods to the students and have them decide whether it would or would not be a wise choice to buy the good. Have them tell why or why not: sock in a plastic bag—no, unnecessary packaging, packaging difficult to recycle and is not usually degradable; glass bottle—yes, refillable or can be recycled; cereal in a box with the recycling symbol on it—yes, it was made from recycled paper, it can be recycled again, it is biodegradable; very large can of pork and beans—yes, the large can is better than many small cans, could be recycled or reused. Remember, reasoning is more important than "correct" answers, as there are often exceptions to be considered. For example, several small cans of beans may be more appropriate to buy than one large can if few people are being served at any one time. This is because leftover beans from a larger can may spoil before they could be eaten.

2. Have students again complete the test handout, ***Making Wise Decisions***.

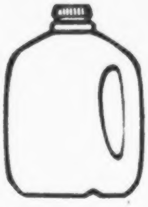
MAKING WISE DECISIONS

1. DRAW A LINE FROM THE DESCRIPTION TO THE PACKAGING IT DESCRIBES

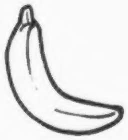
A. Packaging of nature



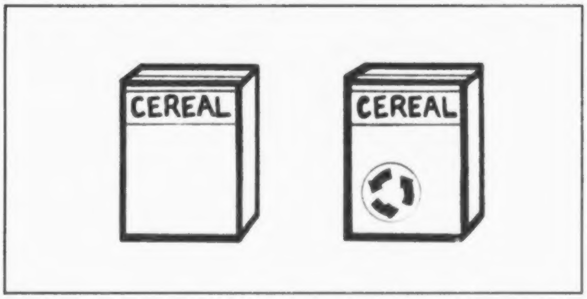
B. Can be reused or recycled

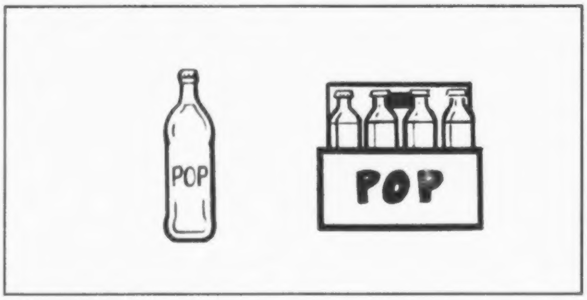


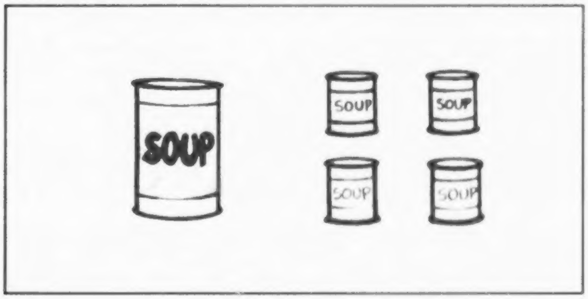
C. Hard to recycle

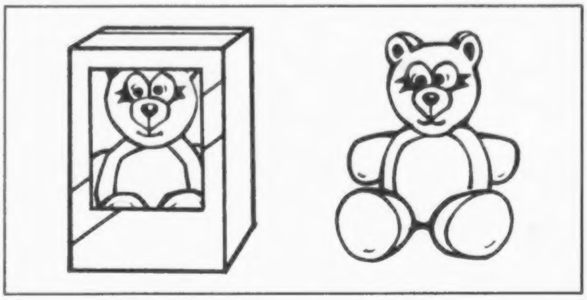


2. CIRCLE THE ITEM IN EACH OF THE TWO CHOICES THAT WOULD BE THE BEST CHOICE FOR SAVING NATURAL RESOURCES AND ENERGY


CEREAL
CEREAL




SOUP
SOUP
SOUP
SOUP
SOUP



INDUSTRY CHANGING WASTE

CHAPTER **9**

ENCYCLOPEDIA

INTERMEDIATE

Objectives

Students will be able to: (1) *compare* changes in production processes that have created changes in the generation of waste by modern industries, (2) *explain* why stronger regulations and recycling have become important aspects of waste management. Students will improve their ability to *conduct research*.

Method

Students gather information from resource texts and *write a report* answering specific questions about the use of resources and wastes produced in the production of specific manufactured goods.

Duration: several class periods for research

Setting: classroom, school library, home

Subjects: Social Studies, Language Arts

Curriculum Reference: 8.1

Preparation

The teacher should make sure that reference material is available to students, including books and encyclopedias from the school library.

Vocabulary

energy, hazardous waste, industry, manufacturing, resources, waste by-products

Handout

Resources And Waste In The Making Of A Bicycle

Procedures

1. Give each student or research group the handout, ***Resources And Waste In The Making Of A Bicycle***. As you discuss the terms on the handout ask students questions that relate to research questions they are asked to answer in Step 2. (e.g. What do you think happened to the waste by-products generated? Do the materials come from renewable or nonrenewable resources?)

2. Assign a report to be made by each student or by groups of students on how the following concerns or a specific industry changed after the industrial revolution (compare before and after).

   a. Type of energy used.

   b. Type and amount of natural resources used.

   c. Time needed to make the product.

   d. Types of waste and waste by-products produced.

   e. Waste disposal and in what quantities.

   f. Government controls for safety in disposing of the waste generated.

   REMEMBER: It was not until the post WWII period that the regulation of waste disposal by governments (local, state, federal) became widespread. Therefore, answers to "e" and "f" may not only include a comparison before and after the industrial revolution, but also a description of recent regulations and practices. Sample industries include:

   - Textile
   - Steel
   - Weapons
   - Transportation
   - Furniture
   - Farming
   - Publishing
   - Food

3. Plan a field trip to a local manufacturing plant and emphasize that you want a tour guide to

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pay particular attention to resources used and waste generated in the making of the product(s).

Evaluation Presentation of reports and a written answer to the following questions: Why have careful procedures and more government control become necessary for the disposal of waste materials in recent history? Why is recycling important in industry today?

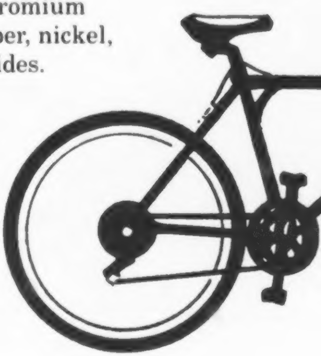
RESOURCES AND WASTE IN THE MAKING OF A BICYCLE

Liquid Waste
Nelson L. Neme
Wesley Pub. Co.
CA, 1

Chromed & Plated Metal Parts

Materials
Chrome, nickel, copper, zinc.

By-Products & Waste
(Highly toxic liquid wastes)
Acids, chromium zinc, copper, nickel, tin, cyanides.



Frame & Other Metal Parts

Materials

Iron ore & coal to make steel.

By Products & Wastes

Ammonia, tar, acids (pickling liquor waste), blast furnace flue dust.

Fe

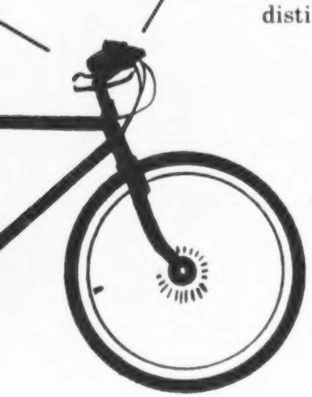
Materials
Aluminum from

Excerpted from *A Way With Waste* (Washington State: Department

of Industry,
row, Addison-
, Menlo Park,
971

Handle bar grips, plastic seat cover, paint, synthetic fibers, synthetic rubber tires

Materials	By Products & Waste
Petroleum & petroleum distillates.	Waste oil from leaks, caustic & acid sludge, alkaline & acid waters, acid gases & filtering clays.



Paints & Coatings

Materials	Wastes
pigments	paints
solvents	solvents
resins	cleaners
cleaners	

enders & Other Metal Parts

	By Products & Wastes
bauxite.	Large volumes of "Red Mud" consisting of iron oxide, titanium & silica.

of Ecology, Litter Control and Recycling Program, 1984), p. 128

TRASH IN HISTORY

CHAPTER **9**

SURVEY RESULTS

INTERMEDIATE

Objectives

Students will be able to *describe* historical changes in the generation and disposal of waste in their community. Students will improve their abilities to *collect data and organize information*.

Method

Students gather historical data by giving a *survey* interview form to an older adult in their community. Students *compare and contrast* information from surveys with present day waste problems. This information is used to *write an historical essay*.

Duration: several class periods during one week

Setting: community and classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 8.1

Preparation

writing materials, material to make a large bulletin board chart

Vocabulary

garbage, litter, packaging, survey, trash

Handout

Adult Interview Form

Procedures

1. This activity requires a week-long period. On Friday give each student an ***Adult Interview Form*** to be completed by the oldest adult relative in the family or a senior citizen in the community.
2. The following week, as the interview forms are brought back to school, compile the information into a chart, one section for each question. You might want to make copies of the completed interview form and cut out answers gluing them according to categories on the chart.
3. At the end of the week conduct a group discussion of the items on the chart. Compare answers to the way we handle our waste today. How have things changed? How have changes caused problems for our environment?
4. Have students predict how the questions on the chart, rephrased in present tense, might be answered when they are grown, reflecting on what must be done with solid waste in the future.

Evaluation

Give students time to look at all the information compiled from all the interviews and have them write an historical essay about why the waste problem has increased over time.

©1988 Ohio Department of Natural Resources; source: Kathy Jaffee, Eastwood School (Oberlin, Oh).

ADULT INTERVIEW FORM

We are learning about how our actions and lifestyles affect our environment. Would you help us by answering the following questions on this interview form. Please think back to what things were like when you were growing up (between the ages of 10 to 20 years old) to answer the questions.

Your Name: ______________________

What years are you remembering to answer this survey? __________

1. WHAT TYPE OF ITEMS DID YOU THROW AWAY IN YOUR WEEKLY TRASH? AND HOW MUCH WEEKLY TRASH DID YOUR FAMILY GENERATE?

2. WHAT HAPPENED TO TRASH AND GARBAGE? HOW WAS IT DISPOSED?

3. HAVE YOU NOTICED MORE OR LESS LITTER IN THE COMMUNITY SINCE YOU WERE YOUNG? WHY?

4. WHEN YOU BOUGHT FOOD OR GENERAL ITEMS AT A STORE, TELL HOW THESE WERE PACKAGED.

ITEM	HOW WAS IT PACKAGED FOR SALE?

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Chapter 10

Waste and Wasteful Habits

COUNT DOWN TO LITTER

CHAPTER **10**

PRIMARY

Objectives

Students will be able to: (1) *describe* litter as waste which is improperly contained; (2) infer reasons why people litter even when containers are nearby. Students improve their abilities to *observe* and to *graph* data.

Method

Students find a piece of litter in their community and *measure* how far it is from the nearest container. They make bar graphs to represent their findings. They *write* reasons why people litter, in spite of the proximity of containers, by making bubble pictures.

Duration: four to five class periods

Setting: classroom, home and community

Subjects: Social Studies, Math, Language Arts

Curriculum Reference: 7.3

Preparation

Students should know something about graphing and units of measure. Needed are: paper grocery sacks, pencils and/or crayons (dark magic marker and rope are optional); comic strip cartoons

Vocabulary

container, graph, litter, measure

Handouts

Litter Information; Litter Graph

Procedures

1. Discuss litter. It is a waste material that is put in the wrong place or has been allowed to escape from a container. Then assign the students an after school task of finding a piece of litter at a neighborhood playground, church lot, ice cream shop, grocery, restaurant or any place they travel that evening. Give each student a paper sack and have them bring the litter in the sack to school the following day. Tell students the item of litter could be as small as a cigarette butt, but no larger than the sack.
2. At the same time you explain this procedure, give each student a "Litter Information" slip cut from the handout, ***Litter Information***. Go over the three questions that are to be answered and brought to school with the littered item. Instruct the students that as soon as they find their piece of litter, they are to locate the nearest trash can and count out how many heel to toe steps to that trash can (using their feet as standard units of measure). They should convert their measurements to a standard system (metric or English) when continuing the assignment in class. If there is no trash can in the area, they should just state that. Instead of using their feet, you may wish to have students make their own measuring devices with a six foot long piece of rope, marked off with a magic marker mark every six inches or so. In similar fashion a metric measure could be made.
3. As the students come to school the teacher can label the bag of litter with each student's name and clip the information slip to it.
4. Prepare to make a graph by collecting information from the slips. Convert all forms of measurement to metric or English measures. Discuss how many students had to take 0-20 feet (or metric measure), 21-40 feet, over 41 feet, or no steps because there was not a trash can in sight. Record this information on the blackboard. The students can then take turns describing and displaying their piece of trash, telling where they found it, and stating how many steps to the nearest trash can.
5. Give each student the handout, ***Litter Graph***, to complete by using information from the board.

©1988 Ohio Department of Natural Resources; source: Carla Paulin, JC Sommer Elementary (Grove City, Oh).

Instruct them to make a bar graph by counting up the numbers on the left side that match the figure for each category that was put on the board. Students should use a ruler and pencil to darken over the horizontal line between the vertical lines of each column and shade with pencil or different colored crayons from the bottom of the column up to the line.

6. Further discuss reasons for not depositing trash when a container is nearby (e.g. don't care, not important, don't feel responsibility for other's actions, didn't realize personal litter can build up and be harmful, etc.). Discuss reasons or attitudes for not depositing trash when container is far or nowhere around (e.g. inconvenient to walk to trash can, bothersome to hold for a long while, blew away and too much trouble to catch, didn't realize that personal litter can build up, etc.). Discuss how people find many reasons for what they do, but that littering, no matter what the attitude or reason of the litterer, is still not accepting one's responsibility to put waste in its place.

Evaluation Give students sheets of comic strips. Have them cut out a character, glue it close to the bottom of a sheet of paper, and give the character a new litterbug related name, to be written beside the character. Then have the student place a conversation bubble over his or her character with a common excuse for littering when a trash can is nearby. Have students choose another character, name him/her and write in a bubble a common excuse for littering when a trash can is far away or there is no trash can around.

LITTER INFORMATION

1. What is the item of litter you found? ____________________
2. Where did you find your litter?

____

3. How many steps to the nearest trash can?

____

4. Convert "steps" to English or metric units. ____________________

- -

1. What is the item of litter you found? ____________________
2. Where did you find your litter?

____

3. How many steps to the nearest trash can?

____

4. Convert "steps" to English or metric units. ____________________

- -

1. What is the item of litter you found? ____________________
2. Where did you find your litter?

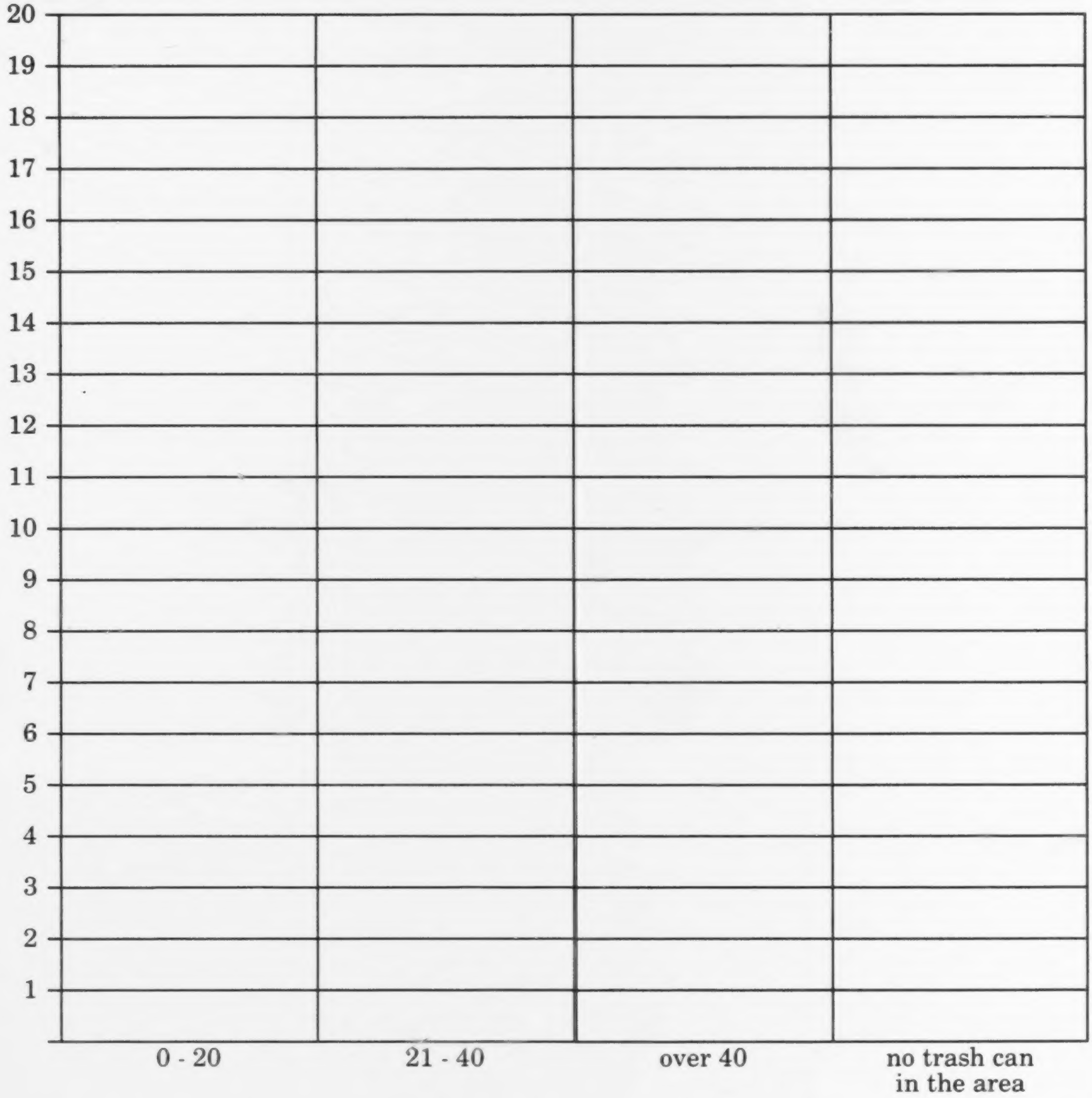
____

3. How many steps to the nearest trash can?

____

4. Convert "steps" to English or metric units. ____________________

LITTER GRAPH



PUT AN **X** IN THE CORRECT SPACE TO ANSWER THE QUESTIONS BELOW AFTER THE BAR GRAPH HAS BEEN COMPLETED.

1. For which distance from a trash can was there the most litter?

______ 0 - 20 ______ 21 - 40 ______ over 40 ______ no cans in area

2. For which distance the least?

______ 0 - 20 ______ 21 - 40 ______ over 40 ______ no cans in area

INVASION OF THE POLLUTIANS

CHAPTER 10

PRIMARY

Objectives

Students will be able to *describe* the effects of littering and particular situations that induce groups of people to litter or generate waste. Students will improve their ability to *solve problems.*

Method

Students listen to a story and assume the roles of two contrasting character types in the story. They discuss and write about their feelings as litterer and/or as someone who keeps others from littering and who cleans up. They describe and act out particular social situations that present groups of people with an opportunity to litter. They discuss and implement solutions to classroom litter problems.

Duration: four to five class periods

Setting: classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 7.1

Preparation

Book – *The Wump World* – by Bill Peet (Houghton Mifflin Company, 1970); writing materials

Vocabulary

behavior, litter, pollution

Handout

Grammar and Mechanics Review

Procedures

1. Read aloud the book, *The Wump World.* (Wump World, inhabited by Wumps, was a beautiful, unpolluted world until it was invaded by Pollutians from Pollutus. The Pollutians drove the Wumps underground and nearly destroyed Wump World by polluting the air with smoke, littering the land and polluting the water with waste. When they left Wump World, there was only one grassy meadow remaining. Slowly Wump World recovered, but it would never be the same.)
2. Discuss the book as a class: What are some things the Pollutians did after they landed in Wump World? What were the effects of the things the Pollutians did? How do you think the Wumps felt after their planet was polluted by the Pollutians? In what ways are the actions of the Pollutians similar to those of people on our earth?
3. Have students complete the handout, ***Grammar and Mechanics Review***. Discuss answers and statements.
4. Explain to the class that they will participate in a simulation activity in which they assume the roles of the Wumps and the Pollutians. Divide the class into two groups. One-half of the room will be the Pollutians. They will throw their litter on the floor of the classroom. The other half of the room will be the Wumps. They will abide by the litter law by throwing their litter into the classroom waste baskets. At the end of three days, have the students discuss what they observed about the half of the class designated as Pollutians and the half of the class designated as Wumps: What did they notice about the Pollutians' side of the room? The Wumps' side? How were the two sides different? Considering the Pollutians' side of the room, how did it make students feel?
5. Have students identify group situations where the people involved might be considered *Pollutians.* Identify age or sex of group, place and activity involved. (Example: young boys at theatre

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watching a movie; parents at home generating garbage; teenage girls riding around town in an automobile; senior citizens at a baseball game.) Ask students to suggest what could be done to keep people from littering in these situations. Plays could be produced in groups with role(s) of Wumps and Pollutians being acted out in regard to these situations.

6. Have students suggest ways they could prevent littering in their classroom. Each week implement a different suggestion. Have the students observe and record, for each day of the week, the effect their suggestion has on the amount of litter in the classroom. After implementing each suggestion, have the students review their recorded observations to determine and discuss which suggestions were most effective in preventing littering.

Evaluation

Have students answer the following questions:

1. Name some people who litter.
2. Name something that happens to our environment because of littering.
3. List as many things as you can that people can do to help stop littering.

GRAMMAR AND MECHANICS REVIEW

Directions: Read the sentences. Put in correct capitalization and punctuation. Circle the nouns. Put a box around the verbs.

1. the wumps lived in a beautiful unpolluted world

2. help wump world is being invaded by the pollutians

3. the pollutians threw litter everywhere polluted the air with smoke and put waste in the water

4. the wumps moved underground to live

5. what caused the wumps to leave their world

6. the pollutians had almost destroyed wump world with all the pollution

7. there was only one grassy meadow left in wump world

8. the pollutians decided to leave wump world because it was so polluted

9. the pollutians are gone yelled the wumps

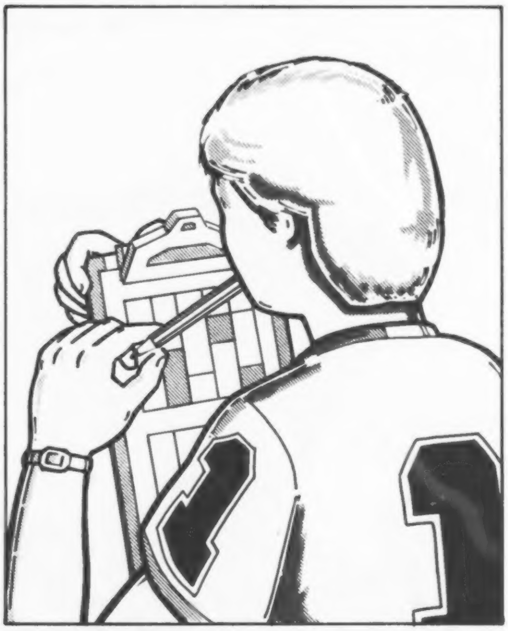
10. all the wumps worked together to clean up the pollution

11. how did wump world look now

12. some of the beauty began to return to wump world but it would never be the same

SURVEY YOUR HABITS

CHAPTER 10



INTERMEDIATE

Objectives Students will be able to: (1) *describe* human habits, which improve their environment and which degrade their environment; (2) *explain* why people act in ways which improve or degrade their environment. Students will improve their abilities to *graph* information from a survey and to *solve problems*.

Method Students use a prepared survey to gather information. They represent data on a chart and make a graph. Survey data is discussed and solutions to undesirable environmental behaviors are proposed.

Duration: four to six class periods

Setting: school, home (optional)

Subject: Social Studies

Curriculum Reference: 7.3

Preparation writing materials, rulers, two different colored pencils or crayons

Vocabulary degrade, desirable, graph, habit, improve, personal environment, survey, undesirable

Handouts ***Personal Environmental Action Survey; Survey Graph; Explaining the Survey***

Procedures

1. Begin a discussion with the question: "What is your personal environment?" Students will probably say their home, some may say it is everywhere they are at any given time. Have a student look up the words in a dictionary and share the definitions with the class. Try to arrive at an operational definition: THE THINGS THAT ARE IN YOUR IMMEDIATE SURROUNDINGS THAT AFFECT YOU.
2. Ask students to list all the things that make their environment look good and that make them healthy. Place some of the answers on the board. Now ask students to list all the things that make their environment look bad or that might hurt them. Place some of these answers on the board. Compare and discuss the two lists.
3. Discuss the word behavior — and ask students what type of behaviors improve their personal environment. Identify these as *desirable* behaviors. Ask students what behaviors degrade their environment. Identify these as *undesirable* behaviors. Pass out the handout, ***Personal Environmental Action Survey***, and discuss it. Have the students complete the survey, being as honest as possible. After they finish, discuss as a class which behaviors on the survey would improve the personal environments of the students, and which might degrade their personal environments.
4. Tally the *yes* and *no* answers in chart fashion on the blackboard or chart paper. Have a student volunteer collect answers by counting hands and putting tally numbers on the chart.
5. Give students the handout, ***Survey Graph***, and have them complete it using the information recorded on the board or chart paper.
   a. Have students observe that each horizontal bar is divided into a *yes* space and a *no* space running across the page.

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b. For each question, students are to find how many *yes* answers there are and how many *no* answers. They record these on the graph by making horizontal color bars, filling in all *yes* bars with one color and all *no* bars with another color. (Or students could use different pencil markings for *yes* and *no* answers.)

c. To make color bars for each question students can put their ruler vertically on the chart and line it up with the number of *yes* and *no* answers recorded for the question. They make a vertical mark to indicate the designated number. Then they color in the bar over to that mark. Number 21 on the chart has been done in this fashion using "X's" and "O's".

6. Have students give the survey to other students in the school that are not in their class. Graph and compare results. Or, have each student take the survey home to give to an adult. Graph and compare results in class.

Evaluation Give each student the handout, ***Explaining the Survey***, to work on.

PERSONAL ENVIRONMENTAL ACTION SURVEY

Instructions: Place a check (✓) to indicate the behavior that best describes what you do.

YES NO

____ ____ 1. I put paper scraps in my pocket when there is no trash can nearby to throw them in.

____ ____ 2. When I see trash that someone else has thrown on the ground, I usually leave it there because I didn't put it there.

____ ____ 3. I buy returnable soda bottles and return them to the store when I need more.

____ ____ 4. I sometimes throw trash out of the car window when I travel.

____ ____ 5. I put all trash into the garbage including materials I could recycle.

____ ____ 6. I have a cluttered room with no container for trash.

____ ____ 7. When I rake leaves in the fall, I put them into a trash can or trash bag to be thrown away.

____ ____ 8. I throw away all food containers and paper bags after they are used.

____ ____ 9. I throw all old, out of style clothing away in the trash and buy more.

____ ____ 10. I sometimes throw trash on the ground.

____ ____ 11. I throw returnable bottles in the trash.

____ ____ 12. I separate recyclable materials such as aluminum and newspaper from other trash, and then I take them to a recycling center.

PERSONAL ENVIRONMENTAL ACTION SURVEY - Page 2

YES NO

____ ____ 13. When I put the trash out for pickup, I sometimes forget to close the lid tightly.

____ ____ 14. I reuse paper bags and food containers.

____ ____ 15. I give my old clothes to someone who can use them, or I use them as cleaning rags rather than throwing them away.

____ ____ 16. I pick up trash I find on the ground even though I did not put it there.

____ ____ 17. I make sure there is a bag for litter in the family car when we travel, and I empty it in the trash when we get home.

____ ____ 18. I sweep and clean my room and empty the trash from it daily.

____ ____ 19. When I put the trash out for pickup, I make sure that the lids are tightly secured on the cans.

____ ____ 20. I have a compost pile where I put leaves for making better soil in my garden or flower bed.

SURVEY GRAPH

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
21	Y	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
	N	O	O	O	O	O	O																								

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
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EXPLAINING THE SURVEY

Instructions: Now that you have completed the survey and tallied and graphed the information, what have you learned? What can you change? What problem can you confront and help solve? Choose one of the problem questions below and answer it; your teacher may want you to answer more than one of the questions.

1. Look at the graph. Choose the question, or one of the questions, that scored the highest "yes" tally. Is it an environmental habit which would improve your environment or one which would degrade it? Why was it answered "yes" so many times? If it is a behavior which would degrade your environment, tell why it should be changed.

2. Look at the graph. Choose the question, or one of the questions, that scored the highest "no" tally. Is it an environmental habit which would improve your environment or one which would degrade it? Why was it answered "no" so many times? If it is a behavior which would degrade your environment, convince the class it should be changed.

3. Find five undesirable behaviors in the survey and give examples of each. Report how your class scored in the five you chose. Mention one way you could change each undesirable habit.

4. Find five desirable behaviors in the survey and give examples of each. Report on how your class scored in the five you chose. Mention ways you could convince others to acquire the same desirable habits.

YOU HAVE INFLUENCE

CHAPTER 10

INTERMEDIATE

Objectives

Students will be able to: (1) *describe* littering behaviors in a group situation; (2) *hypothesize* ways to prevent littering. Students improve their abilities to *write creatively* and *solve problems.*

Method

Students create skits based on designated situations and roles within a group. They *observe* and *analyze* littering behaviors in each skit. They discuss norms, sanctions and techniques which can reduce litter and they rewrite skits to include these.

Duration: seven class periods

Setting: classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 7.1

Preparation

litter items needed as props; furnishings that could serve as background props for the five situations described in Step 1 (A-E); writing materials

Vocabulary

awareness, behavior, containment, formal sanction, informal sanction, littering, norm, technique

Handout

Littering and Anti-Littering Behaviors

Procedures

1. Divide the class into groups. Each group is to create a short play based on a situation and designated roles. You could use any or all of the situations and designated roles described below in A-E. Instruct groups that in their *situation* they are to present as many examples of littering as possible. They are to write out scripts for each role to be played, with role players speaking to each other, but no one is to say why they littered in the script, and no one is to clean up the litter in the script.

   A - SITUATION: A family at home for the evening
   ROLES: mother, father, aunt or uncle, older brother or sister, younger siblings

   B - SITUATION: A group of friends at a playground
   ROLES: leader of group who is oldest, strongest, smartest; boys and girls; park attendant who is an older young adult

   C - SITUATION: A group of high school friends at a football game
   ROLES: leader of group who is the most popular, smartest, strongest; popcorn seller who is an adult; ticket seller who is an adult; other young adult boys and girls

   D - SITUATION: School office during school day
   ROLES: principal, assistant principal, secretary, nurse, janitor, student

   E - SITUATION: Beach during summer time
   ROLES: two mothers or two fathers, a group of young friends, life guard

3. After each group presents its skit, have the other students in the class complete the handout, ***Littering and Anti-Littering Behaviors.*** Discuss answers before the next group presents its skit.

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4. When all groups have finished, write the following terms on the board and discuss.
    - Norms (Anti-littering norms should be represented in the answers to "B" and "C" in the handout.)
    - Sanctions (punishment for littering; formal and informal sanctions)
    - Containment techniques (opportunities created by distribution of containers)
    - Awareness techniques (cues — signs, etc., which prompt people to throw away litter)
5. Have the same groups develop another skit, this time including as many examples as they can of norms, sanctions and techniques to cause those role players who littered in the first skit to pick up their litter in the new skit.

Evaluation Have each student make a list of five ways to reduce littering. Go over the lists with students asking them to identify examples of anti-littering norms, formal and informal sanctions and containment and awareness techniques.

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SITUATION: ____________________

A. Describe three ways people littered in the situation and give a reason why they littered in each case.

1. ____________________

Reason: ____________________

2. ____________________

Reason: ____________________

3. ____________________

Reason: ____________________

B. Who in the group do you think has the most influence over the others in the group?

Role Description: ____________________
Why does this person have the most influence over others in the group? What could this person do to influence others in the group not to litter?

____

____

____

____

____

C. Describe what another person in the group could have done to influence others in the group not to litter.

Role Description: ____________________ What could this person have done?

____

____

____

____

____

MERITORIOUS BEHAVIOR

PRIMARY/INTERMEDIATE

Objectives Students will be able to: (1) *classify* waste materials for purposes of reuse and recycling; (2) *explain* the importance of rewarding positive behaviors associated with litter prevention and recycling. Students will improve their ability to *solve problems*.

Method Students are presented with four ways to conserve waste materials in the classroom, school and community. They initiate action to earn a merit badge for cleaning up litter, and/or for recycling and/or for saving items to be reused. They explain their observations in writing.

Duration: a continuous activity which could last several months

Setting: classroom, school, community

Subject: Social Studies

Curriculum Reference: 7.3

Preparation The teacher should already have introduced lessons and information about items that can be recycled. The teacher must eventually obtain the support of parents and community members so that students can earn merit badges. Needed are: large garbage bags, four pieces of chart paper, four coffee cans, a large box, a decorated trash can, boxes for recycling.

Vocabulary cleanup, litter, positive behavior, recycling, reuse, reward

Handouts ***How To Earn A Merit Badge; Merit Badges***

Procedures

1. Have a student collect all clean litter from the classroom floor for one week and place it into a large garbage bag. Prepare four charts with the following headings:

   reusable   art projects   recyclable   trash

   Empty the collected trash onto a large table or area and place the charts in the front of the room. Have students examine the classroom litter and decide what items are recyclable (newspaper, etc.), reuseable (crayons, pencils, paper clips, etc.), able to be used in creative art projects (construction paper, etc.), or must be thrown away. Discuss which type of litter there is most of in the classroom and why.

2. Prepare places for the future collection of waste items so that they can be taken to a place in the classroom related to one of the categories above.
   a. For *reusables* label coffee cans for various items — pencils, crayons, paper clips, thumb tacks — and put these in one place.
   b. For *art projects* have a large box.
   c. For *recyclables* keep paper grocery sacks to collect newspapers, a tall box labeled "aluminum cans," and another box labeled "glass." You may also want to collect steel cans and plastic pop bottles if there is a collection place for these in your community.
   d. For *trash* decorate the garbage cans in your room.

3. Students can use grocery sacks or garbage bags to collect litter from the playground, lunchroom, bathroom and halls. Help students classify trash according to the four categories. They can then place trash in the proper places. Hold a discussion about differences between classroom litter and litter on the school grounds.

source: Carla Paulin, JC Sommer Elementary (Grove City, Oh).

4. Discuss ways to motivate people to clean up and to recycle including the use of monetary rewards or voluntary efforts. Explain how the class can initiate a program to motivate students to clean up and recycle. This program can be explained by going over the requirements indicated on the handout, ***How To Earn A Merit Badge***. Family members and community members will need to assist students in their efforts. Discuss recycling with students and have them decide what weight amounts to put in the blanks on the "testimony" forms. Merit badges for students can be cut out when they earn them. See the handout, ***Merit Badges***. You could also have a few students make up a "Board of Review" to cut out a supply of badges ahead of time and distribute them based on review of testimony slips brought in by students. Ribbons on badges could be colored in and different colors for the same badge could be used to designate the extra efforts of students (who accumulate, for example, five regular badges).
5. Cut up and keep a supply of testimony slips on hand from the handout, ***How To Earn A Merit Badge***.
6. This activity can be an ongoing project throughout the year. You may even offer that your class conduct the merit badge project on a school-wide basis for all students.

Evaluation

Have students write an essay about why they think the Merit Badge Program has motivated more students to keep the school clean and to recycle. Have them offer suggestions for improving the program.

Litter Picker-Upper Badge Testimony

A. Find a place that is littered in your neighborhood or community.
B. Using a trash bag, clean up the area.

Answer the following:

1. Where did you clean up? ____________________

2. Name some things that you found: ____________, ____________

____________, ____________, ____________

Have parent or neighbor observe and sign below:

____
signature

Newspaper Recycler Badge Testimony

1. Student must find the closest recycling center which accepts newspaper.

Where is it located? ____________________
address

2. Student must collect from home and/or neighbors, at least ________ lbs. of newspaper to recycle. (amount determined by the class)

____________________ OR ____________________
parent's signature recycling center operator's signature

Aluminum Recycler Badge Testimony

1. Student must find the closest recycling center which accepts aluminum.

Where is it located? ____________________
address

2. Student must collect from home and/or neighbors, at least ________ lbs. of aluminum to recycle. (amount determined by the class)

____________________ OR ____________________
parent's signature recycling center operator's signature

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Glass Recycler Badge Testimony

1. Student must find the closest recycling center which accepts glass.

   Where is it located? ______________________________
   address

2. Student must collect from home and/or neighbors, at least ________ lbs.

   of glass to recycle (amount determined by the class)

   ______________________ OR ______________________
   parent's signature recycling operator's signature

- -

Creative Litter Project Maker Badge

1. Student must create an art project using waste material.
2. A description of my project: ______________________________
3. The litter I have used is: ______________________________

____
teacher's signature

- -

Things in Place Badge

1. I have collected ______________________ waste items that could be reused which I have
   (amount determined by class)

   found in the classroom or school.

2. The litter and waste materials I have found are listed on a separate sheet of paper according to the containers I put them in: for reusables, for art projects for recyclables, for trash.

____
teacher's signature

- -

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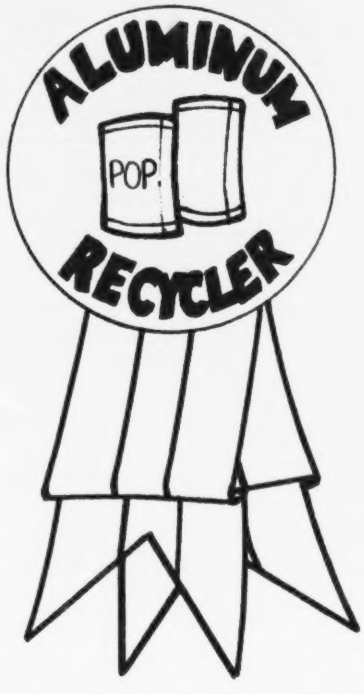
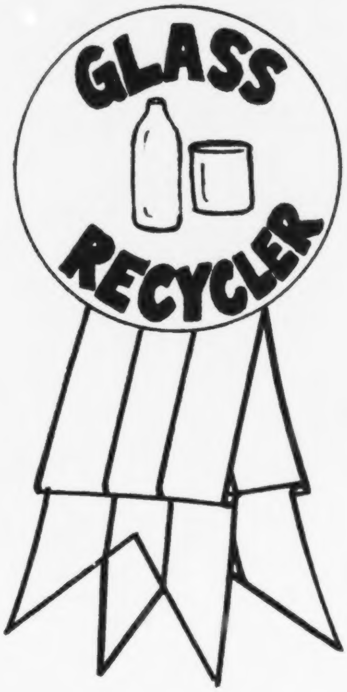
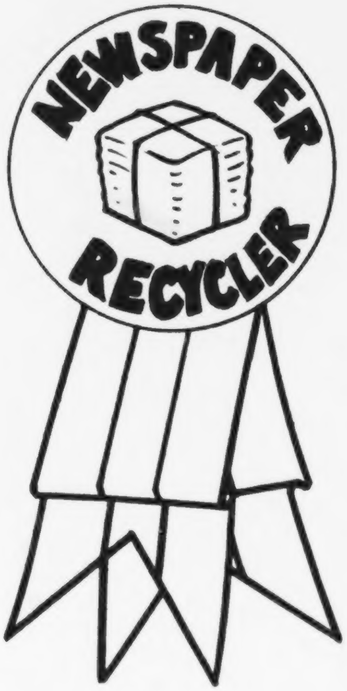
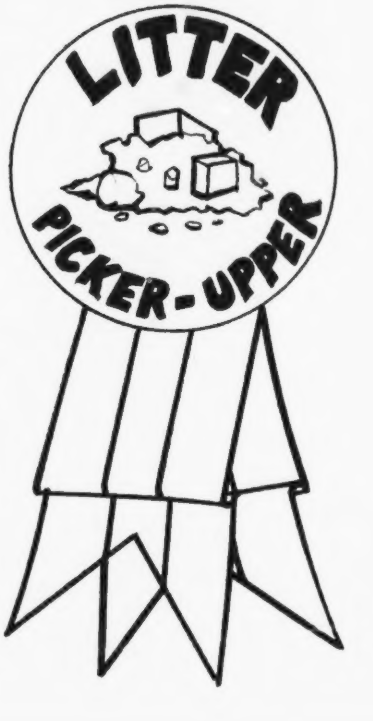
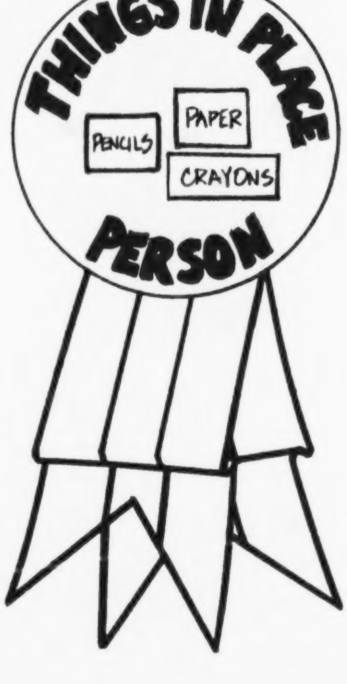
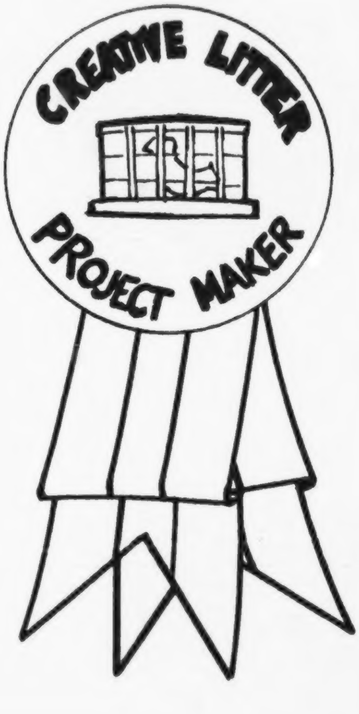

ALUMINUM
POP.
RECYCLER


GLASS
RECYCLER


NEWSPAPER
RECYCLER


LITTER
PICKER-UPPER


THINGS IN PLACE
PAPER
PENCILS
CRAYONS
PERSON


CREATIVE LITTER
PROJECT MAKER

Chapter 11

Getting Out the Message

THE LITTER ALERT

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *identify* litter and waste as community problems; (2) develop messages to make the public aware of these problems. Students will improve their abilities to *write creatively*, to *solve problems* and to *manipulate materials*.

Method

Students solicit schoolwide responses to waste problems and broadcast these in a "Hallway Television" setup. "Litter critters" are made and discussed as part of the television message. The students write and act out television broadcasts (to be recorded on videotape if equipment is available).

Duration: a couple of class periods a week, for several weeks

Setting: classroom, school

Subjects: Social Studies, Art, Language Arts

Curriculum Reference: 5.1, 7.3, 8.2

Preparation

large roll of white paper for people-size cut-outs, large roll of colored paper as background (such as light blue), markers, construction paper, glue, masking tape, a suggestion box, articles of litter (cans, bottles, paper and fast-food packaging), art supplies for *litter critter* creations, a videotape recorder if available

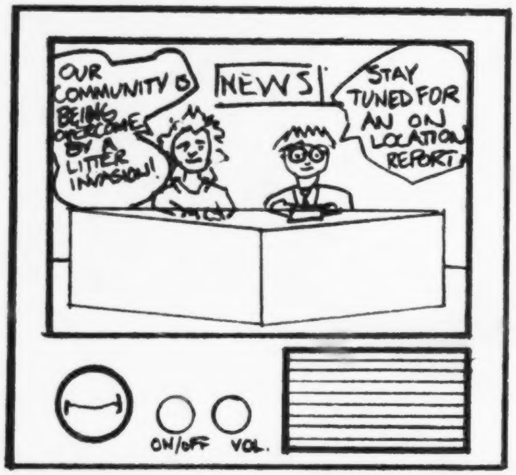
Vocabulary

litter, news broadcast, public service announcements, waste crisis

Procedures

1. Prepare a large (8′ × 10′) paper background, frame it as a TV screen with construction paper, and mount it on a wall along a well traveled hallway in your building. Make a life-size cut-out of two students (a boy and a girl) sitting at a news desk. This is to be mounted on the TV screen, but in such a way that it can be removed and put back again.

2. Prepare the TV screen to look like a newsroom, with the figures delivering the news via balloon-type cartoon captions. The newscasters are reporting to the community about the dreaded litter invasion. This display can be left up for about a week to create interest throughout the school. In the meantime the class can be preparing *litter critters* to appear on next week's news flash.


OUR COMMUNITY IS BEING OVERCOME BY A LITTER INVASION!
NEWS
STAY TUNED FOR AN ON LOCATION REPORT
ON/OFF
VOL.

3. Have each child bring in a piece of litter to be decorated as a critter by adding legs, wings, antennae, etc.

4. After a few days or a week, change the TV screen and have an *on location* reporter (lifesize cut-out), reporting the tragic invasion of litter critters while surrounded by the litter critters each student made. A request for suggestions as to how to alleviate the problem can

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be made, with answers to be delivered on upcoming newscasts. Put a *station* suggestion box in front of the TV screen. Students making good suggestions can have their answers presented in the cartoon format by the station news anchors which can be returned to the screen. Each answer can be left up for a couple of days or so depending on the number of responses. Ideas actually implemented can be presented with a follow-up report in future newscasts. NOTE: This same exercise could be used to address the issue of a waste crisis, including problems of scarce landspace and pollution. Students could present news broadcasts (in bubbles) about the crisis and about the potential of recycling as one way to reduce waste. In this case a suggestion box about ways to motivate people to recycle or to conserve materials to prevent waste could be put in front of the TV screen.

5. In class have students write dialogues for the news anchors based on stories about their litter critters. Students should name the critter, tell where it came from or how it was created and tell what is going to happen to it.
6. Students can also work in groups to create litter alert messages. They are to identify a problem, write and edit their message, then videotape the completed project. Some groups could create public service announcements to be included as advertising spots between the news broadcasts. The advertisements could be of many types; some possible suggestions are: a. highlight a city which disposes of its waste efficiently and which has reduced landfill space requirements by initiating a community recycling program; b. an advertisement for a new type of recycling machine; c. an ad about children who don't litter and what happens to the environment when people do litter.

Evaluation Following completion of the activity, tell students that for the next month they are to find and record as many examples as they can of "media messages" about waste problems. These can include television news broadcasts, signs and billboards, newspaper articles, commercials, etc. about litter, recycling and waste management.

SIGNS AND SLOGANS

CHAPTER **11**

WHAT IS YOUR MESSAGE

PRIMARY INTERMEDIATE

Objectives Students will be able to identify and create logos and slogans as public service announcements about litter prevention, waste management and recycling. Students will improve their abilities to *write and draw creatively*.

Method Students are introduced, through class discussion and a handout, to the varieties of public service announcements which utilize slogans and logos. With the use of other handouts in special formats, students design their own logos and slogans for T-shirts, billboards and bumper stickers.

Duration: four to five class periods

Setting: classroom

Subjects: Social Studies, Language Arts, Art

Curriculum Reference: 7.4

SPECIAL NOTE: This activity coordinates very well with the implementation of a cleanup or recycling drive and with *Ohio Recycle Month* and *Clean Up Ohio Week*.

Preparation writing materials, rulers, crayons and colored pencils, posterboard, poster paint optional

Vocabulary litter, logo, public service announcement, recycling, sign, slogan, waste management

Handouts ***Logos Mean Something; T-Shirt Message; Bumper Sticker Message; Billboard Message***

Procedures

1. Ask the class what a public service announcement is. Discuss examples from radio and television spots and draw attention to slogans and/or logos used in these. Write some slogans and logos on the board.
2. Ask students about other methods of making public service announcements using written messages, slogans and logos. Draw students' attention to the covers of this guidebook, identify the message and logo on the binder. Discuss. Have students think of ways to make messages about various issues of contemporary importance that may include the use of bumper stickers, billboards and T-shirts.
3. Give each student the handout, ***Logos Mean Something***, to complete. Discuss and have students explain the meaning of the logos they created.
4. You may now use the remaining three handouts, ***Billboard Message, T-Shirt Message*** and ***Bumper Sticker Message***, in any way you wish. The following are some suggestions:
    a. Discuss with students different issues associated with litter (creates health problems, is against the law, is unsightly causing a blight on the landscape and urban-areas); recycling (different products can be recycled, energy and resources can be saved by recycling); waste management (we are running out of landfill space; the job of garbage collectors is necessary and important).
    b. Tell the class they are to take part in a slogan contest (which can also include pictures and logos). Plan to give prizes for each category represented by the handouts in this ac-

source: Elaine Struck, Donnelsville Elementary (Donnelsville, Oh) and David Landis, DLPR.

tivity. Or, instead of using the handouts, you could have a poster contest and supply poster board and other materials.

c. Remind the class that the slogan must be about litter prevention, waste management and/or recycling. (If you have chosen this activity to coincide with *Ohio Recycle Month* or *Clean Up Ohio Week*, then you will want to restrict the theme accordingly.)

d. After projects are finished, arrange for a panel of judges (other students in the school, other teachers, parents, etc.) to decide on the best three projects in each category.

e. You can gain some publicity by posting the best projects in businesses and public offices in the community, or by getting your local community to sponsor the production of T-shirts, bumper stickers or even billboards with the designs of the winning projects.

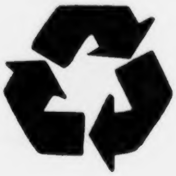
Evaluation Have each student write an essay answering the following question: Why are signs with logos and slogans on them important?

LOGOS MEAN SOMETHING

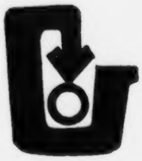
Directions: Answer each of the questions below.

1. What do the words "litter prevention" mean? (Describe in your own words.)

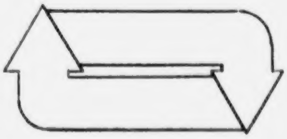
2. What is recycling? (Describe in your own words.)



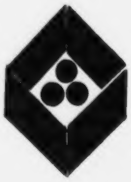
A



B



C



D

3. Look at the four logos above. Which two do you think symbolize *litter prevention?* Answer by circling the letters below that correspond with the letters of the logos above which you think symbolize *litter prevention.*

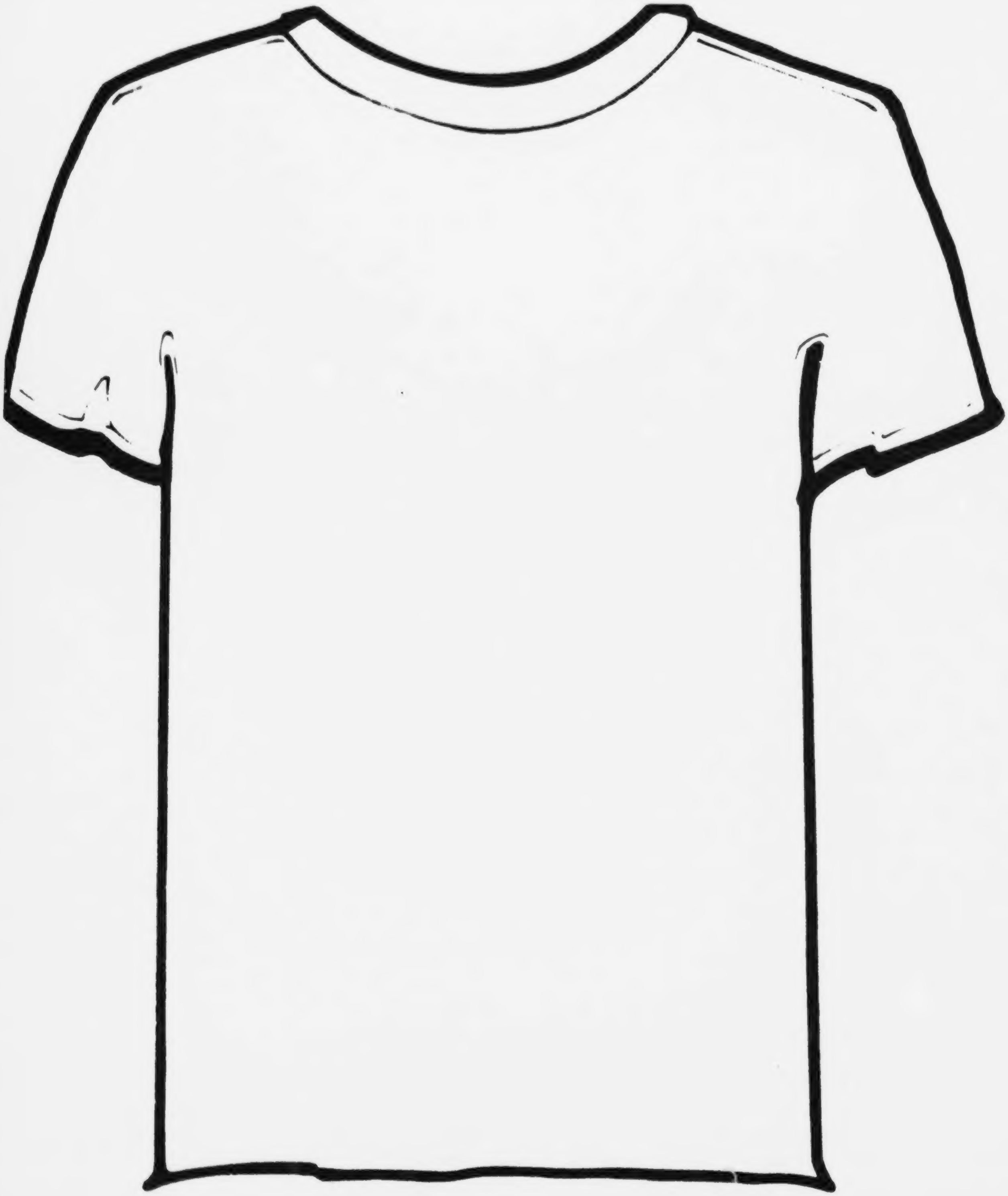
A B C D

4. Which two logos do you think symbolize *recycling*? Answer by circling two letters again.

A B C D

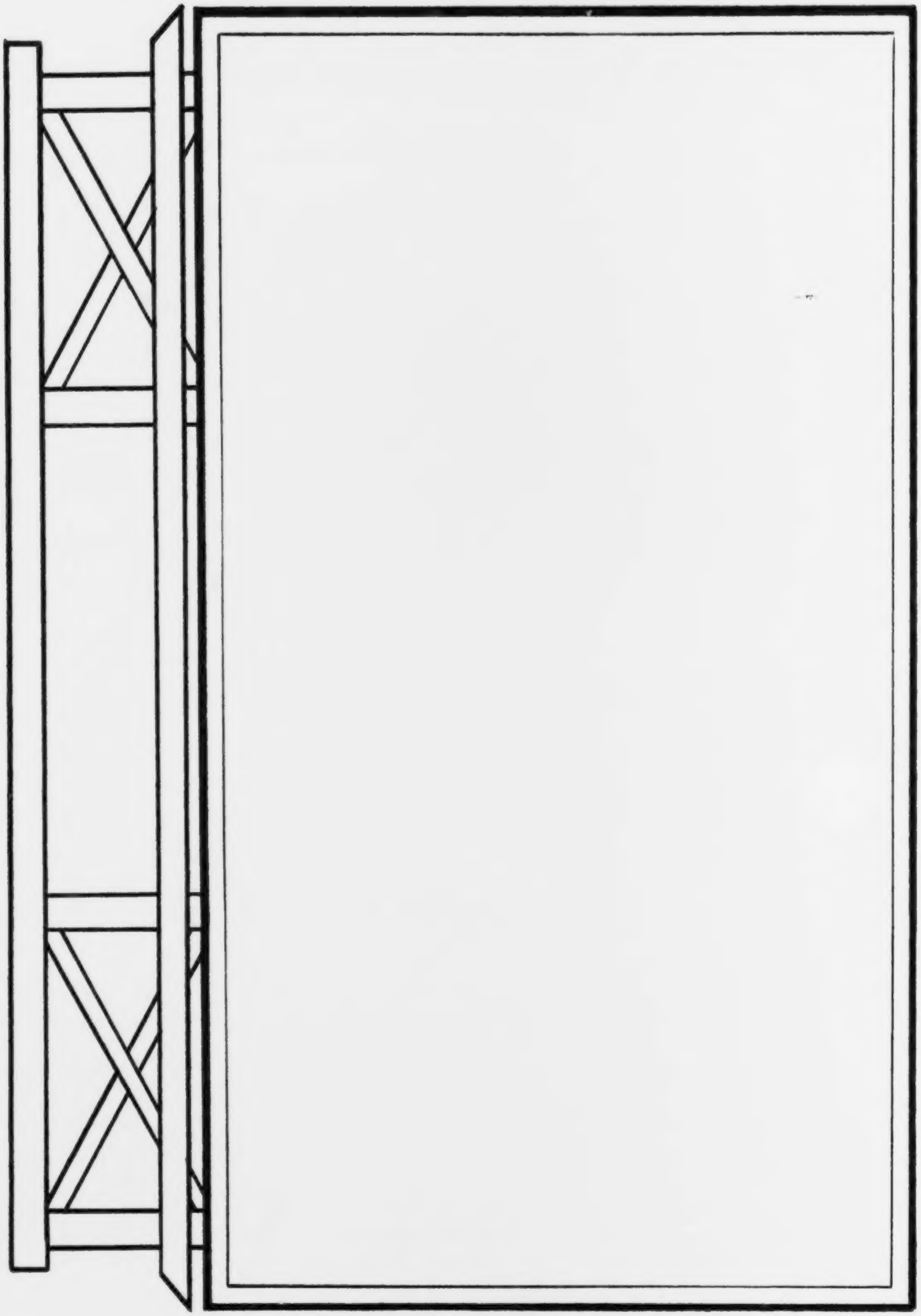
5. Discuss the answers above with your teacher. Then make your own logo on either the back of this page or on a separate sheet of paper. Make it about litter prevention or recycling or both, but it must be one design only.

T-SHIRT MESSAGE



BUMPER STICKER MESSAGE

BILLBOARD MESSAGE



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RECYCLING DRAMAS

CHAPTER **11**

TAKE ONE
DIR

INTERMEDIATE

Objectives

Students will be able to: (1) *describe* how recycling saves resources. Students will improve their abilities to *listen* and *gather information* and to *communicate a message.*

Method

Students listen to a story and discuss concepts related to recycling and the conservation of resources. They complete a handout requiring them to identify the meaning of words in a specific context. These words are about recycling and conservation. Students apply research and communication skills in the creation of dramas. They *cooperate in groups* to create plays to be presented to other classes in the school.

Duration: three class periods and time to produce a play

Setting: classroom, school

Subjects: Social Studies, Language Arts

Curriculum Reference: 2.2, 7.3

Preparation

The Lorax by Dr. Suess; paper and pencil, may need materials to make props for plays; video tape equipment if available

Vocabulary

litter, recycling, resources

Handout

Words to Know

Procedures

1. Read to students *The Lorax*. Discuss the once renewable but then depleted resource in the story and how it can be renewed. Discuss how we can recycle paper, glass and aluminum as a way of conserving natural resources. Also, discuss the creative way Dr. Suess delivered his message in *The Lorax*. This will help enhance the students' own creativity later.

2. Lead a discussion about nonrenewable resources. When they are gone, they are gone for good. Examples of these are iron ore (used to make steel), petroleum (used to make plastics, synthetic fibers and synthetic rubber) and bauxite from which aluminum is extracted. Ask students how we can conserve these resources. For example, by recycling aluminum we can cut down on the need for bauxite and also protect the earth from being excavated. And when we recycle, there are fewer items to be sent to landfills. If we recycle and reuse, we have fewer materials to throw away.

3. In order to introduce students to important concepts of this lesson, have each student complete the handout, ***Words to Know***.

4. Give the following assignment to students: They are to convince people of the importance of recycling. They are to do this in groups through writing and producing plays. Students will need to convince their audience that recycling can save natural resources and help protect the earth. Discuss and/or engage students in the following exercises as ways to give them ideas for the content of their plays:

   a. Taking recyclable objects from a trash can, have students write a pictorial life history of these different kinds of useful trash. What natural resources were used in the making of the different items? Students could do a little research to discover what natural resources can be conserved by recycling.

   b. If available, find out the price for newspapers and aluminum cans from your local recycling center. Make up math problems to show students how a school can make money

©1988 Ohio Department of Natural Resources; source: Brenda J. Green, Summit Elementary (Summit Station, Oh)

by recycling. Example: On recycling day our school took in 2050 pounds of newspapers and 450 pounds of aluminum cans. If we were paid 10¢ per pound for newspapers and 22¢ per pound for aluminum cans, how much did we earn?

c. Make a list of items you might find in a landfill. Place them on a chart according to *Recyclable, Reusable* and *No Apparent Use*. Discuss with the students how recycling can help conserve land space.

5. Have students choose groups to produce plays. Remind them how creative Dr. Suess was in *The Lorax*. Their plays can be serious, humorous, or make-believe, but they must get their message across. They need to be convincing. You may wish to have students produce puppet dramas described in the activity, **PUPPET DRAMAS**, which follows this one.
6. Present plays to different classes in the school. This is a good way to promote a school recycling program. As an option, the production of a videotape of the plays will generate much interest.

Evaluation

Play productions

WORDS TO KNOW

Directions: Use the following vocabulary words to fill in the blanks of the paragraph. Study the definitions before completing the paragraph. Use the context to help you.

Natural: anything in our world not made by people or machines.

Nonrenewable: incapable of being replaced except through a long process of thousands of years.

Renewable: having the capacity of being regenerated or made new or fresh again; being able to be restored to original state or condition.

Resource(s): something that can be used to make something else — wood into paper, iron ore into steel, bauxite into aluminum, sand into glass.

Recycling/Recycled: to pass through a series of changes in the process of creating a new or different product from existing materials; reuse of natural resources and human-made products.

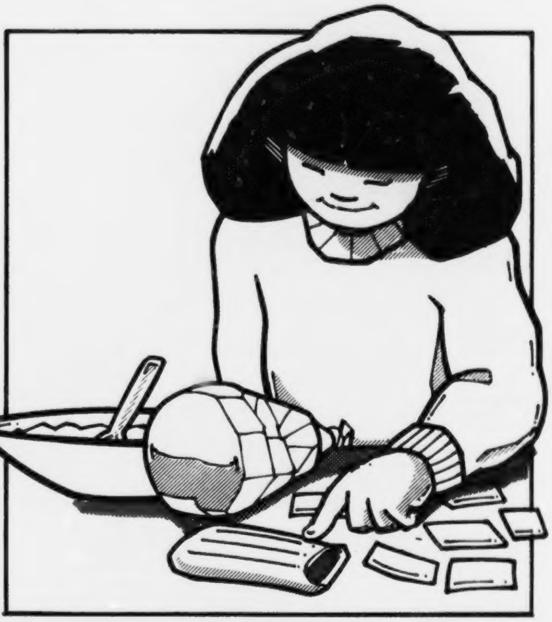
Conservation: helping to preserve, not waste, the Earth's resources.

Land space: places in communities or natural areas that do not have buildings or roads.

Today we took a field trip to a ______1______ center where people take their glass, newspaper and aluminum cans to be ______2______ . Recycling is a good way we can practice ______3______ by reusing the Earth's ______4______ resources. Two ______5______ that we learned about are bauxite and trees. Bauxite is a ______6______ resource containing aluminum. Once it has been used up it can not be restored. By recycling aluminum we will not use as much bauxite. Recycling newspapers helps conserve trees which are ______7______ resources. Trees can be planted to replace the ones that are cut down, but it takes many years for them to grow. We also learned that recycling helps save ______8______ . By earning money from newspapers and aluminum cans, people may save them to recycle instead of throwing them away. Most of what we throw away is buried in landfills.

PUPPET DRAMAS

CHAPTER 11



INTERMEDIATE

Objectives Students will be able to *explain* the importance of litter prevention, recycling and waste management. Students will improve their abilities to *manipulate materials, write creatively* and *cooperate in groups.*

Method Students divide into committees to create plays with scenery and puppets. Plays are performed and evaluated.

Duration: several periods during each of two weeks

Setting: classroom, school, community

Subjects: Language Arts, Arts and Crafts

Curriculum Reference: 7.3

Preparation old socks, balloons, newspapers, flour, water, large bowl, mixing stick, sewing needle and thread, coloring utensils (e.g. magic markers), posterboard, masking tape, thumb tacks, small cardtable, portable blackboard; videotape equipment if available

Vocabulary drama, litter, recycling, waste management

Handout *Making Puppets*

Procedures

SESSION I

1. Create committees: A. script writing committee; B. scenery design committee; C. puppet making committee
2. Before separating into committees, have groups decide the following:
   - setting of puppet show (e.g. on a lake front); suggest possible themes about littering, recycling or disposal problems with setting being a recycling center or landfill
   - how many characters and a brief description of each (e.g., father-30 years old, grouchy; son-10 years old, likes to litter; daughter-12 years old, never litters)
   - brief plot outline (e.g. father and children on beach, father sees son littering . . .)

   Place this information on a blackboard or on posterboard so that all students can refer to it while in their committees.
3. Separate into three groups with each group performing a different task or have three or more groups each making their own play and designate divisions of labor.

   Script Committee: students need to take plot already decided upon and break it into three or four scenes (Scene 1: Father catches son littering. Scene 2: Daughter gets cut on a piece of son's littered glass. And so on.). After three or four scenes have been created, committee should create a dialogue for each scene.

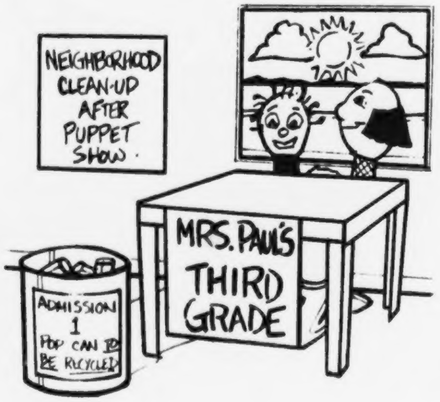
   Scenery Committee: This group tapes two pieces of posterboard together and creates a backdrop for the show. If the group decided the setting is a lake front, then the students will create a drawing on one sheet of posterboard to reflect that. Also, students need to take another piece of posterboard and create a front for their cardtable stage. They can name their group on this posterboard (e.g. Mrs. Gray's third grade class).

©1988 Ohio Department of Natural Resources; source: Jim Petuch, Litter Prevention & Recycling (Mahoning County, Oh).

Puppet Committee: This group creates the puppets. Go over the handout, ***Making Puppets***, with this group and have them follow directions to complete their puppets based on characters created by the Script Committee. In this first session, this committee is to follow directions up to Step 6. Then instruct them to bring in an old sock for each balloon head.

SESSION II
(One Week Later)

4. Divide into groups again. 1. Have script committee finalize script (two or three hand written pages). 2. Have scenery committee finish the backdrop and front piece for your cardtable. 3. Have puppet committee complete Steps 7, 8 and 9.
5. After all three committees are finished, have students choose, from among volunteers, who will be puppeteers. They should then rehearse and give a classroom presentation. Puppet show may be videotaped or performed for other classes.

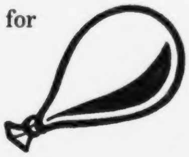

NEIGHBORHOOD CLEAN-UP AFTER PUPPET SHOW.
MRS. PAUL'S THIRD GRADE
ADMISSION 1 POP CAN TO BE RECYCLED

Evaluation

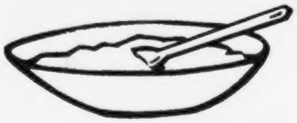
Have each student identify the messages and theme of the play and then explain verbally or in writing the importance of the "message(s)" in the play.

MAKING PUPPETS

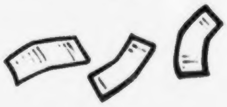
STEP 1: Blow up balloons for puppet head.



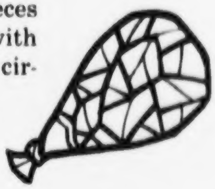
STEP 2. Create glue mixture 1/2 flour, 1/2 water, mix well.



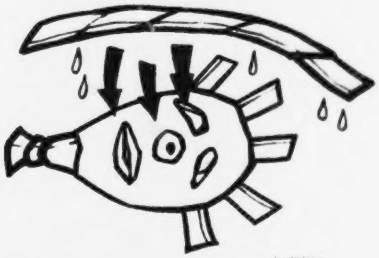
STEP 3. Tear newspaper into 1″ or 2″ pieces.



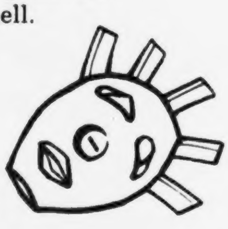
STEP 4. Dip paper pieces in glue, cover balloon with four layers; leave small circle on bottom.



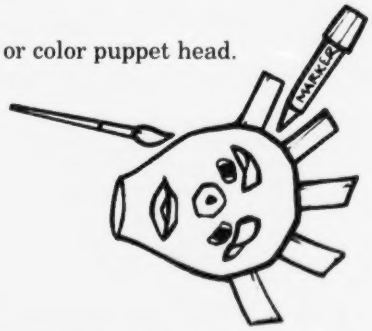
STEP 5. Create special character traits, including hair; use rolled up strips of newspaper to create traits, and dip in glue mixture.

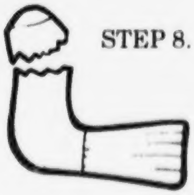


STEP 6. Let dry two days, then adult should puncture balloons, leaving shell.



STEP 7. Paint or color puppet head.

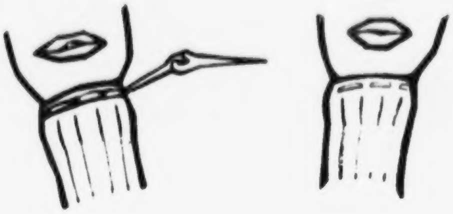




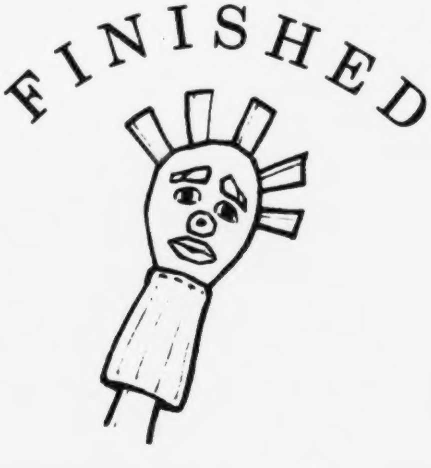
STEP 8. Cut off tip of old sock.

STEP 9. Either

sew or *staple*



top of sock to puppet head.



Chapter 12

Reuse Enterprises

TRASH TO TREASURE SALE

CHAPTER **12**

REUSE MATERIALS
TO CONSERVE
NATURAL
RESOURCES

PRIMARY INTERMEDIATE

Objectives

Students will be able to: (1) *classify* everday items that can be reused, reconstructed or recycled; (2) *describe* the quality and value of items that can be reused. Students will improve their abilities to *cooperate with others* and to *suggest alternatives*.

Method

Students cut out objects to make a chart of reusable items, of recyclable items and of objects which must be reconstructed to be reused. Students bring in reusable items from home and market these items by describing their qualities, possible uses and resale value. Students conduct a mock sale or auction of the reusable items.

Duration: four to five class periods and a flexible amount of time for "Market Days"

Setting: classroom, home

Subjects: Social Studies, Language Arts, Arts & Crafts

Curriculum Reference: 6.3

Preparation

Students bring in any items from home that they no longer use. These items can either be reusable as they are or objects which can be reconstructed to make something else. (Items must be clean — e.g. clothes, toys, books, etc.) Materials to make posters and play money.

Vocabulary

advertise, auction, demand, market, price, quality, reconstruct, recyclable, reusable, sale

Handouts

Reusable Materials and Objects; Classifying Reusable Objects

Procedures

1. Give each student the handout, ***Reusable Materials and Objects***, noting three possible distinctions to be made for the items: a. some can be reused as they are because, although old, they are still functional; b. some are so old and tattered or broken apart that they require creative reconstruction for the material to be reused; c. some are recyclable, meaning that they can be taken to a recycling center and used in remanufacturing processes to make the same or similar products. The recyclable items on the handout are as follow: battery, aluminum can, glass jar, used motor oil, plastic bottle and newspapers. The rest of the items are in pairs, with one object in good used condition while the other is tattered or broken. Before they begin, give students examples of the three distinctions using items not listed on the handout. (e.g. good used sock, tattered sock, steel can) Note that some clothing is accepted by recyclers who cut up tattered materials into useful rags for industry and/or ship old useful clothing to other countries.
2. Make sure students understand what each item is. Then give each student the handout, ***Classifying Reusable Objects***, to complete by cutting out objects on the handout, ***Reusable Materials and Objects***. Discuss answers after completion.
3. Tell the class that they are going to participate in a *Trash to Treasure Day* sale. To do this they need to begin bringing in specific items as mentioned in the **Preparation**. Have each student bring in at least two items: one representing reusability as is and another needing to be reconstructed to be reused.
4. Tell students they can advertise the usefulness and other values of their objects by making post-

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ers about these qualities. To aid in doing this, write a list of objects (not brought in by students) on the board and have students list adjective descriptions for each item that would make it sound appealing to buy (e.g. jacket: "warm," "attractive," "colorful"). Have them think of psychological values for the objects as well (e.g. "will make you popular with the gang," "will make your room cheerful"). If the item which students are trying to advertise must be reconstructed to make something useful, students need to mention this in their advertisements. (e.g. "make a patchwork quilt from old clothing pieces," "making rags from old clothing pieces," "use parts of toys as . . .")

5. When selling is over and the activity is finished, you may want to have students make a *found object* collage or sculpture using the reusable items which need to be reconstructed to be used.
6. Conduct sale where children can sell their *old trash* and buy a *new treasure.*
    a. Make paper money. (Use markers to make money and stamp with one of your teacher grading stamps to prevent counterfeit money.)
    b. You may want to have students earn the play money ahead of time by bringing in recyclable cans (5¢ a can), or completing assignments (10¢ a paper), or establishing good behavior (25¢ a day). (This exercise is good with a Behavior Modification System.)
    c. Decide if the sale will be conducted in an auction or a market format. If initiating a market sale, teacher should discuss pricing with students. One way to do this would be to have students display their posters (which advertise the items) with sign up sheets. Students who want an item write how much they will pay for it. After considering the demand and prices which students are willing to pay, the seller may set a price. Remember to tell students that as buyers, they can buy as many items as they want or need with the money each has. Finally, open the market for sale day(s). Have students draw numbers to see who gets to buy one object first, second, third, etc. Tell sellers and buyers they can change prices at any time to meet demand.
    d. If you decide on an auction format, you will want to ask for student volunteers to be auctioneers.

Evaluation

Hold a competiton to see who can design the most creative and/or most useful reuse for objects which must be reconstructed to be reused. Students can vote for the winners.

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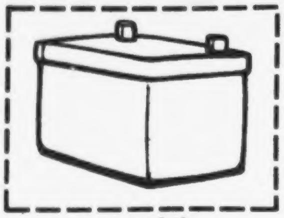
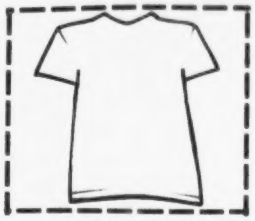
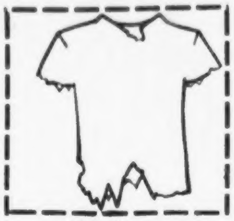
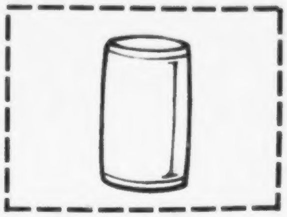
REUSEABLE MATERIALS AND OBJECTS

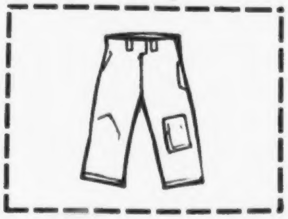
Directions: Cut out each illustration below along the dotted lines. Look at each illustration carefully and put it in the correct column on the handout, ***Classifying Reusable Objects***.

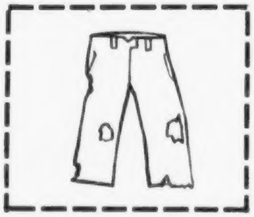

automobile battery

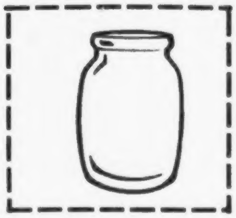

T-shirt

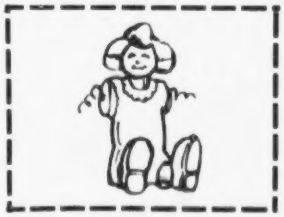

T-shirt

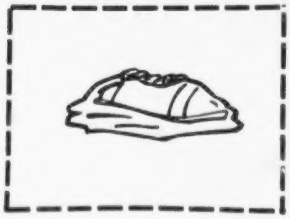

aluminum can


jeans


jeans


glass jar


doll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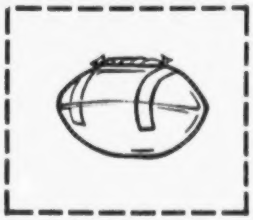
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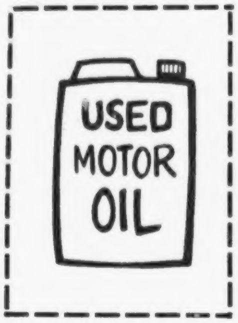

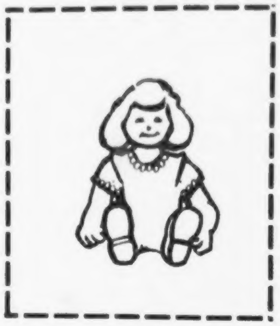
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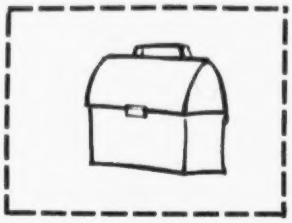
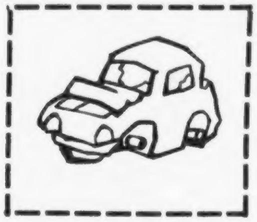
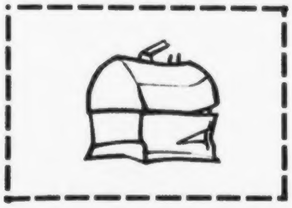
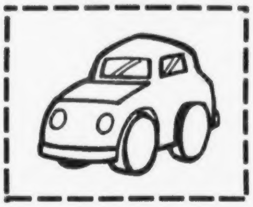
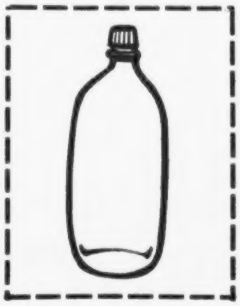
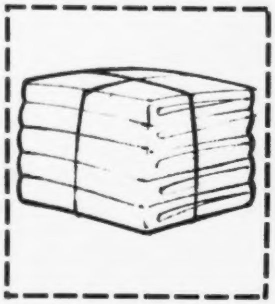

lunch box


toy car


lunch box


toy car


plastic bottle


newspapers

CLASSIFYING REUSABLE OBJECTS

Direction: Classify the objects on the handout, ***Reus***
ries below.

OBJECTS REUSABLE AS THEY ARE	OBJECTS THAT MU INTO SOMETHIN

able Materials and Objects, by putting them into the catego-

UST BE RECONSTRUCTED G ELSE TO BE REUSED	RECYCLABLE OBJECTS

RECYCLEVILLE, USA

CHAPTER 12

REUSE
TOYS
FOR S
$

PRIMARY/INTERMEDIATE

Objectives Students will be able to: (1) *identify* possible reuses for discarded materials; (2) *describe* the requirements and procedures involved in the production and sale of a product. Students improve their abilities to *calculate figures* and to *cooperate with others.*

Method Students organize themselves into company groups to create usable items from discarded materials brought into class. They plan the production and sale of various reuseable items in model production lines and model stores set up in the classroom. They solve math problems related to starting a business.

Duration: many class periods over several weeks time

Setting: classroom

Subjects: Social Studies, Language Arts, Arts & Crafts

Curriculum Reference: 6.2, 6.3

SPECIAL NOTE: This activity can be modified in many ways. It can be made simpler for younger ages, and the possibilities for expanding exercises to include additional economic concepts are limitless.

Included in this activity are instructions for reusing various materials; therefore, an activity related only to the reuse of waste materials can be initiated using this information (with emphasis on saving landfill space and resources).

Preparation The students should be aware of the differences between goods and services and between producers of goods, providers of services and consumers of goods and services. The students should be able to count money and make change. For Steps #1 and #2 below you will need to collect appropriate materials listed under the directions for making various goods in Recycleville *classroom factories*. (See ***Reuse Instructions (A-J)***)

Vocabulary advertising, capital, goods, labor cost, market, overhead cost, profit, production, rent, reuse, selling price, services

Handouts ***Production Planning; Reuse Instructions (A-J)***

Procedures

1. Hold a discussion to make the students aware of the great number of discarded items which can be reused to create new things. Provide examples of items which can be reused; discuss and demonstrate how they can be reused by making creative constructions out of empty dishwashing liquid bottles, gallon milk cartons and computer cards. (See ***Reuse Instructions (A)***)

2. Discuss the following economic terms: goods, services, production, overhead cost and selling price. Tell students that they will become producers and consumers of goods in a classroom activity to be called *Recycleville*. The city of Recycleville will contain stores selling goods made from discarded waste items. These goods will be created in Recycleville classroom factories and then sold in Recycleville classroom stores. The teacher can select the types and numbers of goods to be produced and sold in the Recycleville stores from the list below. Or, arrangements could be made to have students in *company* groups decide what they would like to produce from the list. Directions for making these items can be found at the end of this activity in ***Reuse Instructions (A-J)***. Company groups could also decide to design and make a product not listed in this activity.

©1988 Ohio Department of Natural Resources; source: Gerda Barr, North Franklin Elementary (Columbus, Oh) and David Landis, DLPR

Store Names	Possible Products to be Sold
Quilt Shop	Mini quilts for baby dolls (B)*
Telephone Store	Tin can telephones (B)
Recycleville Art Gallery	Art work made from waste items (B-C)
Music Store	Maracas (C), Tambourines (D), Drums (D-E)
Toy Store	Doll, rockets, boats, cars, trains, trucks (A and E), doll house and furniture (F-G), bleach bottle piggy bank (G)
Sporting Goods Store	Ring toss game (H), plastic milk container ball catchers (H-I), ball paddles game (I)
Puppet Shop	Puppets (I)
Garden Center	Glass jar terrarium (J)
Office Supply Store	Tin can pencil holder (J)

*Letters by each products indicates the section in the ***Reuse Instructions*** where it can be found.

3. Show the students pictures or explain to them the various items that can be produced in Recycleville, based on the ***Reuse Instructions (A-J)***. You may have other items to add to this list. Have students divide into four or five *company* groups, with each group choosing initially one item to produce. After all groups have chosen to make different items, make up individual supply lists for each group based on the ***Reuse Instructions (A-J)***. Divide the supply lists into *material* supplies (reuseable waste items to be brought into the classroom) and *tools* (any items such as scissors, hammer, paper clips, glue, etc. which you will furnish from the classroom).
4. When all groups have made supply lists, make a general classroom supply list of materials (not tools) needed by all groups. Put this on chart paper on the bulletin board. Have students, regardless of their group, collect any of these items and bring them to class. Each group will need to prepare (and decorate if desirable) boxes ahead of time to serve as storage warehouses until materials are to be used. All items should be cleaned before being brought into class. Discuss with students why it can be claimed that by bringing these items to class to be reused, they are saving scarce landfill space and natural resources.
5. Have students make a quantity of play money on slips of paper worth 5¢, 10¢, 25¢, $1.00, $5.00, $10.00, $20.00 and $50.00. Make smaller amounts of each kind of bill as the value of the bill increases. Stamp all money with a teacher's stamp to avoid counterfeiting. Keep all money aside for later use by the *bank* group.
6. After sufficient quantities of reusable materials have been collected, have each group make a count of the quantity of each type of material collected in their warehouses. Make a list on the board or on chart paper of all the materials of all the groups, indicating the quantity of each material collected. In ascending order of scarcity, put at the bottom of the list the material or item of which there is the most until you reach the top which will be the item or material of which there is the least quantity. Discuss how the value of a raw material is often based on its scarcity. Then have students assign monetary values to each item on the list with the scarcest item costing the most (for producers) to buy and the item in greatest quantity being the least expensive to buy.
7. Assemble all the tools and classroom supplies needed to make all of the products. Have the class give these monetary values based on the relative value of materials used to make the item. (Hammer and scissors would be more expensive for producers to buy than paper clips or glue.)
8. Each group is now ready to plan for the production of their product. Give each group the hand-

out, ***Production Planning.*** Before having them work on completing this, you will need to do the following:

a. Either hold a *how to session* demonstrating how each group's product is to be made or make up individual procedure descriptions for each product of each group. To do this refer to the ***Reuse Instructions.***

b. Explain the three sections on the handout. Make sure students understand what a "process order" is (it refers to tasks needing to be performed as indicated on the handout, ***Production Planning***). The pay for each worker should be based on a group decision about the skill of the task so that hourly wages will differ. Specified rules for each worker can include safety rules and cleanup rules.

9. After groups have completed the handout, ***Production Planning***, check their work to see that costs have been figured correctly. Then each group will need to decide how many of each item they want to produce initially. This can be done arbitrarily based on resources available, or with older students, you may want to have them make the following calculations:

   a. Add up the cost of *material* supplies and labor needed to make one item. Based on this cost, how much should be charged to make a profit when selling the item? This should be a *reasonable* price, not too high so that no one would want to buy the product, but a profit must still be made.

   b. How many individual items must be sold at a profit so that tool costs can be paid for and still make a profit? (Tool costs represent capital costs which are relatively fixed; hence tool costs need not be associated with the making of *each* item.) This exercise may require an adjustment in the selling price decided upon in "a."

   c. Students can now speculate about how many items they should produce to cover initial costs.

10. Based on the TOTAL PRODUCTION COSTS (from ***Production Planning*** handout), for materials, labor and tools, each company group can now ask the bank for a loan. (Or, you could make arrangements for companies to sell stock.)

11. Before companies request their loans you may want to add an additional exercise to the activity which includes additional cost considerations to be figured into the *reasonable* sale price and the bank loans. These costs would be representative of "SALES COSTS" including cost to rent space, to advertise and to pay for retail sales labor as indicated in the steps below:

    a. Decide before conducting the activity what materials can be collected and made available to groups so they can advertise their products. This can include poster board, markers, paints, construction paper, scissors, etc. You will need to add these items to the materials list in Step #6 and tools list in Step #7 above, so they can be given a monetary value.

    b. You will also need to decide on rent costs for various *retail* locations in the room and the wage costs for a retail seller in the group.

    c. Students will need to add costs for rent and retail wages to their bank loan requests and costs for these and for advertising (counting advertising as a relatively fixed cost) to their reasonable selling price.

12. After the bank has granted loans to each company, have each group designate a *fiscal officer* to buy materials. Then each company can set up factories for classroom production. This will mean a variety of arrangements.

13. When each group has made a sufficient amount of their product (not necessarily the amount required to cover production costs) they can prepare their product for sale, including advertising efforts. Make sure *fiscal officers* pay laborers in the company for their work. It is with this money that goods will be bought.

14. Designate sale days. May be one hour a day for each of two days during the week.

15. Check to see if consumers have enough money to make one or two purchases of the items. You may have to augment their wages initially with a bank loan, or if they are paid so much that demand will exceed supply of items, you could tax wages.

16. For intermediate grades you may wish to apply the concepts of supply and demand as they affect prices. As a store begins to sell out of all of

its goods you may suggest the owners raise their prices, or lower them, if they are having difficulty selling items. This may mean lowering wages as well.

17. At the completion of a few *Market Days*, students in each store could participate in the following activities:
    a. Count the money collected and compare it to the amount of money spent to produce and sell the good. This will determine the profit. Make a classroom chart for recording production (and sales) costs and profits and outstanding loan amount. Have groups make up a *company report*.
    b. Have companies take inventories.
    c. Continue activity in whatever manner you wish.

Evaluation

1. Have the students compare and contrast orally their roles as producers of goods and as consumers of goods. Have them write an experience story about their Recycleville experiences.
2. Have students answer the following questions orally:
    a. Tell what it means to reuse materials and why we should reuse waste materials.
    b. Identify the following in the activity: goods, services, overhead cost, labor cost, profits, inflation, etc. (for intermediate students).
    c. Name something you could do to make other people aware of the importance of reusing waste materials.

PRODUCTION PLANNING

RECYCLEVILLE, USA

12

Name of Product ____________________

REUSED MATERIALS	CO (per
TOTAL	

TASK EACH WORKER WILL PERFORM (in process order)

TOTAL ____________

Company Name ____________________

ST unit)	TOOLS AND SUPPLIES	COST (per unit)
	TOTAL	

RATE/hr.	SPECIAL RULES

TOTAL PRODUCTION COSTS = ____________________

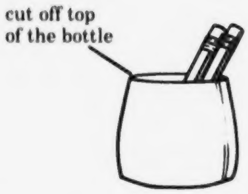
Reuse Instructions (A-J): for use in the activity, Recycleville, U.S.A.

These ideas can also provide the basis for a general reuse activity.

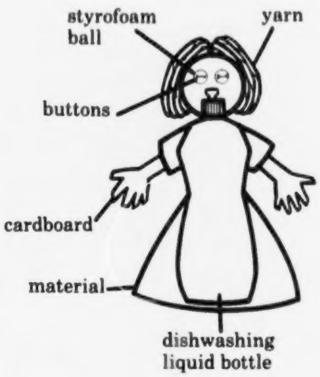
REUSE INSTRUCTIONS (A)

A. Reuse empty plastic dishwashing liquid bottles in the following ways:

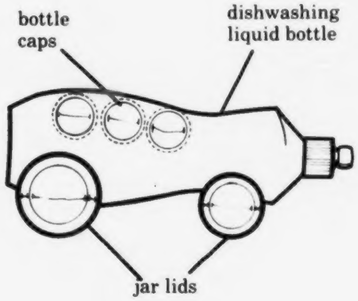
1. Container for pencils


cut off top of the bottle

2. Doll

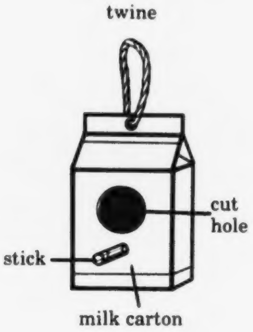

styrofoam ball
yarn
buttons
cardboard
material
dishwashing liquid bottle

3. Space age car

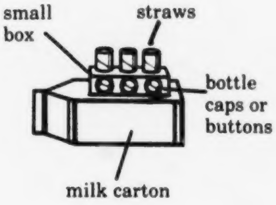

bottle caps
dishwashing liquid bottle
jar lids

B. Reuse empty milk cartons in the following ways:

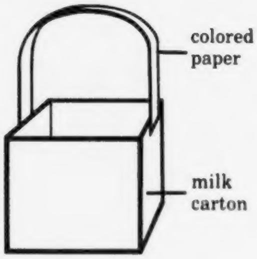
1. Birdhouse*


twine
cut hole
stick
milk carton

2. Boats

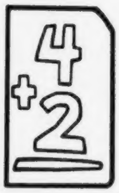

small box
straws
bottle caps or buttons
milk carton

3. Basket*

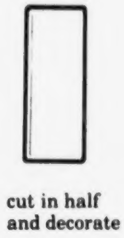

colored paper
milk carton

C. Reuse computer cards in the following ways:

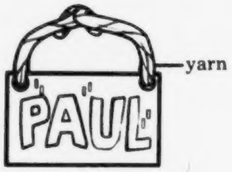
1. Flashcards



2. Bookmarks


cut in half and decorate

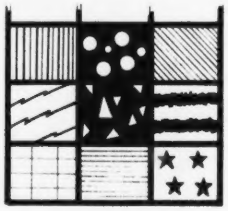
3. Nametags



* Reprinted with permission from Lion Books, Publisher, Scarsdale, N.Y. From pages of *Cardboard Carpentry* © 1966. Lion Books.

Mini Quilts for Dolls

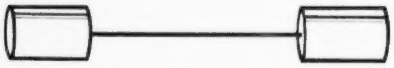
Materials needed for each quilt:
1 10″×12″ piece of material
20 2″ squares of material in a variety of colors and patterns
scissors
rubber cement



1. Cut piece of material 10″ × 12″ and cut 20, 2″ squares from a variety of colors of material.
2. Lay the 10″ × 12″ piece of material on a desk.
3. Leaving a half inch border, arrange the 2″ squares in a design on top of the 10″ × 12″ material.
4. Put rubber cement under each square of material and press the square down to hold it in place. (You could also make quilts using colored paper scraps or wallpaper scraps.)

Tin Can Telephones

Materials needed:
2 tin cans with one open end on each can
2 paper clips
1 ball of string
1 tin punch
1 hammer



1. Punch a hole in the center of the bottom of each can using the tin punch and hammer.
2. Cut the string to the desired length.
3. Put the end of the string through the holes.
4. Tie paper clips to the ends of the string so that the string will not slip out of the hole in the can. (Telephones can also be made using styrofoam or paper cups. Use a pencil to poke a hole in the bottom of each cup. Then follow the directions above for attaching the string.)

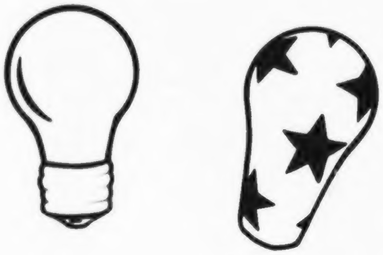
Art Work

1. Mosaic pictures can be created using bits of colored egg shells (shells from hard boiled eggs colored with Easter egg dye), pieces of nut shells or old pieces of colored floor tile.

2. Sculptures made from waste materials can be created. Examples include the following:
    a. Container Sculpture - using milk cartons or plastic containers;
    b. Box Sculpture - using boxes of various sizes and shapes;
    c. Aluminum Foil Sculpture - using foil saved from packed lunches;
    d. Toothpick Sculpture or Stick Sculpture;
    e. Wire Sculpture;
    f. Sponge or Foam Rubber Sculpture;
    g. Paper Sculpture or Papier-Mache Sculpture;
    h. Wood Scrap Sculpture.
3. Collages can be created using scraps of material, wallpaper or colored paper, magazine pictures, buttons, toothpicks, bottle caps, jar lids, straws, used sandpaper, string, yarn, etc.
4. Applique Pictures in which material scraps are sewn on to a larger piece of material can be created.
5. Mobiles can be made from waste materials.
6. String or yarn pictures and designs can be created.

Maracas

Materials needed:
- scissors or paper cutter
- newspaper
- papier-mache paste
- bowl for mixing paste
- spoon for mixing paste
- 1 large burned out light bulb
- sandpaper
- tempera paint
- paint brush
- shellac or varnish



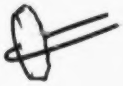
1. With scissors or a paper cutter, cut the newspaper into 1/2" wide strips.
2. Mix the papier-mache paste.
3. Dip the strip of newspaper into the paste until it is thoroughly wet. Lift the strip out of the paste and gently pull it between two of your fingers in order to remove excess paste.
4. Put the strip on the light bulb and smooth it down to remove wrinkles and bubbles.
5. Continue putting the strips in different directions on the bulb until it is covered. Repeat this procedure until at least five layers of strips have been put on the light bulb.
6. Let the maraca dry thoroughly.

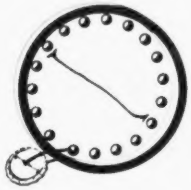
7. Hit the maraca on the floor to break the bulb inside.
8. Use the sandpaper to sand the maraca until it is smooth.
9. Paint designs on the maraca with tempera paint.
10. Shellac or varnish the maraca.

Tambourine

Materials needed:
- 1 large margarine tub lid
- 1 ball of string
- 25 pop bottle caps
- 1 tin punch
- 1 hammer
- scissors

1. Using the tin punch, make 25 holes around the top of the margarine tub lid near its edge.
2. Use the tin punch and hammer to punch a hole in the center of each pop bottle cap.
3. Cut 25 pieces of string, each about 2 1/2″ long.
4. Thread one piece of string through each bottle cap.
5. Thread each string with a bottle cap on it through a hole in the margarine tub lid and tie the ends in a knot.

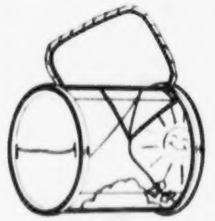




Drum

Materials needed:
- 1 two-pound coffee can with the top and bottom cut off
- 2 two-pound coffee cans lids made of plastic
- 1 ball of string
- light colors of colored paper and small scraps of colored paper in a variety of colors
- crayons, markers
- yarn
- glue
- tape
- scissors

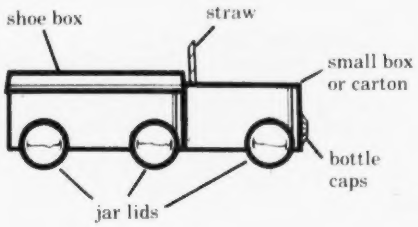
1. Choose a piece of colored paper. Wrap it around the outside of the can and cut it to fit the can. Tape it to the can.
2. Decorate the colored paper by gluing yarn, scraps of other colors of colored paper, etc. to it. Write or draw designs on it with crayons and markers.
3. Cut a piece of string 30" long. Thread it through the can and tie the ends.
4. Put one coffee can lid on each end of the coffee can.
5. Put the string around your neck and pound on the ends of the drum.



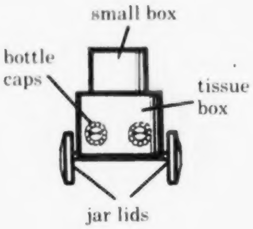
Toys for the Toy Store

Students can be creative in designing airplanes, boats, cars, trains, trucks, rockets, spaceships etc. from different sized boxes, jar lids, milk cartons, spools, bottle caps, straws, cardboard, colored paper, etc. Examples:

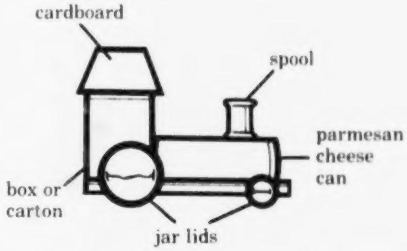
Truck


shoe box
straw
small box or carton
bottle caps
jar lids

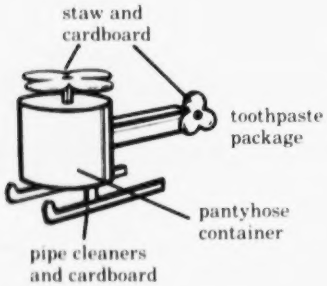
Car


small box
bottle caps
tissue box
jar lids

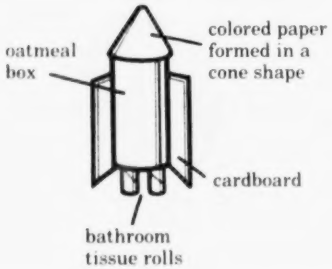
Train


cardboard
spool
parmesan cheese can
box or carton
jar lids

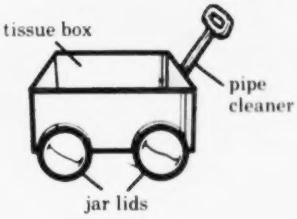
Helicopter


staw and cardboard
toothpaste package
pantyhose container
pipe cleaners and cardboard

Rocket


oatmeal box
colored paper formed in a cone shape
cardboard
bathroom tissue rolls

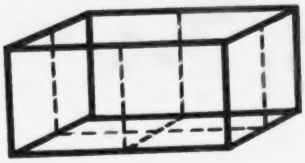
Wagon

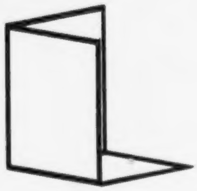

tissue box
pipe cleaner
jar lids

Doll House*

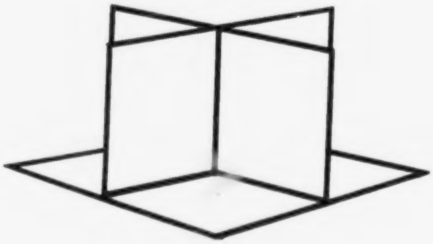
Materials needed:
- 1 box
- glue
- scissors
- scraps of wallpaper and colored paper
- tempera paint
- magazines
- scraps of cloth

1. Cut the box down the center of each side. You will end up with four pieces of the box that look like this:





2. Put the corners of each piece together and glue them. You now have a doll house with four rooms.



3. Have the children decorate each room with wallpaper scraps or paint the walls. They can use the material scraps to make curtains. Magazines could be used to find decorations for the walls.

Doll Furniture*

Materials needed:
- bottle caps
- spools
- small boxes, such as spice boxes, jello and pudding boxes, jewelry boxes, match boxes
- corks
- straws
- caps from containers (for lampshades)
- cloth scraps
- colored paper scraps
- wood scraps
- jar lids

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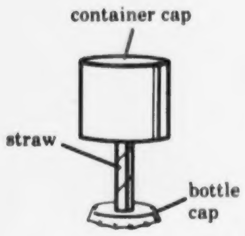
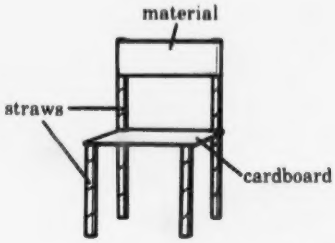
REUSE INSTRUCTIONS (G)

Students can be creative in designing chairs, tables, lamps, dressers, beds, etc. Examples:

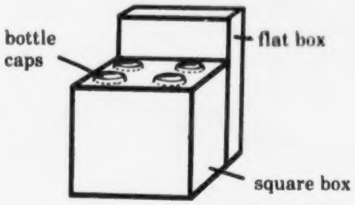
Lamp


container cap
straw
bottle cap

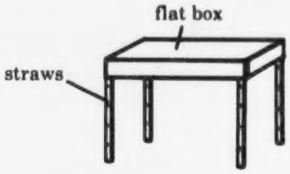
Chair


material
straws
cardboard

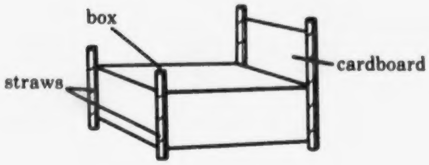
Stove


bottle caps
flat box
square box

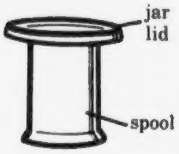
Table


flat box
straws

Bed


box
straws
cardboard

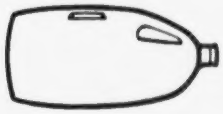
Table


jar lid
spool

Bleach Bottle Piggy Bank

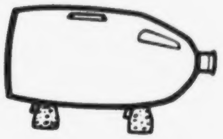
Materials needed:
- 1 empty plastic liquid bleach bottle thoroughly rinsed
- 4 corks
- permanent magic markers in an assortment of colors
- 2 buttons (optional)
- colored paper
- 1 pipe cleaner
- glue or tape
- scissors

1. Cut a slit in the side of the bleach bottle below the handle. It should be large enough for coins to fit through.

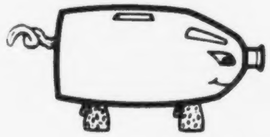


2. Glue the four corks on the bottom of the bleach bottle for the pig's legs.

3. Draw eyes with permanent magic markers or glue buttons on for the eyes. Draw a mouth.



4. Curl a pipe cleaner around your fingers to make a tail for the pig. Glue or tape it on the end of the bleach bottle.

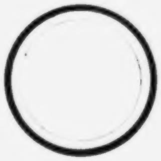


5. Make ears for the pig from pink colored paper. Glue or tape them on both sides of the bleach bottle.
6. Cut a circle of pink colored paper and glue it to the top of the cap of the bleach bottle.
7. Decorate the pig with markers or colored paper.

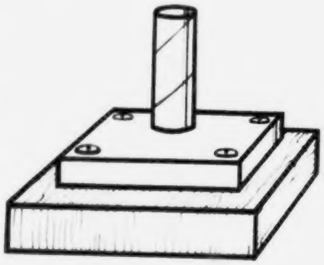
Ring Toss Game*

Materials needed:
- 1 cardboard tube from aluminum foil, plastic wrap or waxed paper
- 4 large margarine tub lids
- 1 flat rectangular box
- 1 flat rectangular scrap of wood larger than the box
- scissors
- tape
- tempera paint - any color
- 4 nails
- 1 hammer

1. Cut out the inside of the margarine tub lid so that only a rim remains. Do this to all four lids. This will make the rings to be tossed.



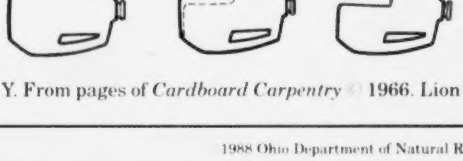
2. Cut a hole in the middle of the flat rectangular box. Push the cardboard tube through the hole and tape it to the box.
3. Nail the corners of the cardboard box to the wood scrap.
4. Paint the ring toss game. When it is dry, put it on the floor. Toss the rings so that they will land on the cardboard tube.



Plastic Milk Containers Ball Catchers

Materials needed:
- 2 one-gallon plastic milk containers
- scissors
- one used tennis ball

1. Using scissors, cut part of the bottom of the milk container off so that a scoop shape remains.



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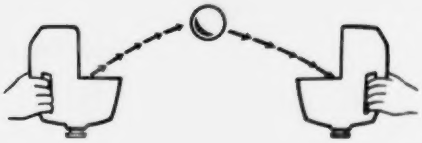
REUSE INSTRUCTIONS (I)

2. Follow the same procedure for the second milk container.

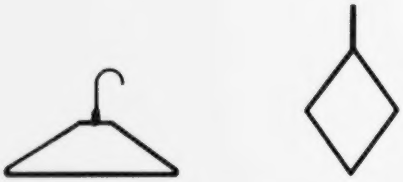
3. Two people may play with the ball catchers. One person puts a ball in his/her catcher and tosses it to another person with a catcher. That person tries to catch the ball and then toss it back. Continue tossing the ball back and forth.



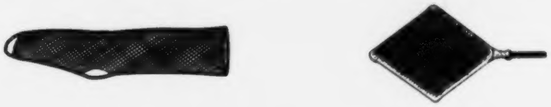
Coat Hanger/Pantyhose Paddles

Materials needed:
- 2 coat hangers
- 1 pair of pantyhose
- masking tape
- scissors

1. Bend the hanger into a diamond shape. Bend the hook so it is straightened. (You may want to tape the end or add a wooden handle.)

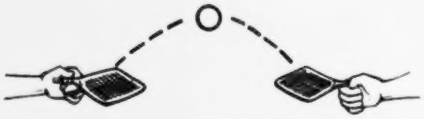


2. Cut one leg off of the pantyhose. Pull the pantyhose leg over the coat hanger. Stretch the pantyhose tightly over the hanger. Tape the open end of the pantyhose to the straightened part of the hanger.



3. Follow the same procedure for the second hanger.

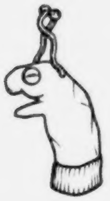
4. Using a light weight ball, hit the ball back and forth.



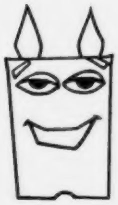
Puppets

Allow the students to be creative in designing puppets using a variety of waste materials. They could make one or several of the following types of puppets:

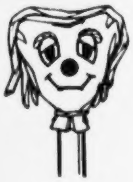
Sock Puppet



Paper Bag Puppet



Newspaper Stuffed Paper Bag Puppet on a Stick



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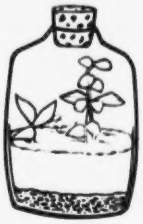
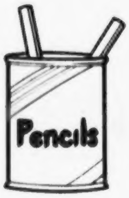
Glass Jar Terrarium



Materials needed:
- 1 large mouth jar
- uncolored aquarium gravel
- sterilized soil
- spoon
- small plants that like moisture and shade
- cork to fit the opening of the jar

1. Put about an inch of aquarium gravel in the bottom of the jar. This will help the drainage.
2. Spoon about two inches of soil over the gravel and spread it out evenly.
3. Using the other end of the spoon, make a hole in the soil for planting a small plant.
4. Put the plant into the hole and spoon the soil around its roots. Follow the same procedure for other plants.
5. Moisten the soil evenly with sprinkles of water.
6. Place the cork in the top of the jar.
7. Put the terrarium in a place where it receives light but not direct light.

Tin Can Pencil Holder



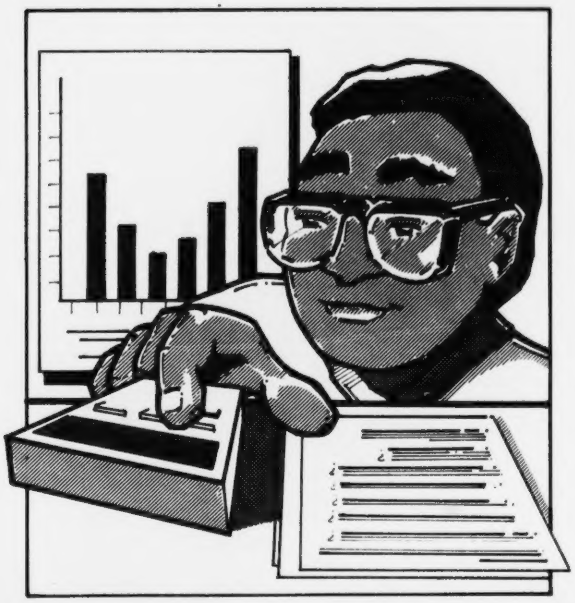
Materials needed:
- 1 tin can (soup can)
- 1 strip of colored paper 9″ × 3-3/4″
- glue
- magic markers

1. One end of the can should be open. Remove the label from the can.
2. Draw a design or write messages on the 9″ × 3-3/4″ strip of colored paper. The students could also glue seeds, beads, shells, buttons, etc. on the paper to decorate it.
3. Wrap the strip of colored paper around the outside of the can and glue the ends together.
4. Use the can as a pencil holder.

Chapter 13

Work, Waste and Money

ECOLOGY CASH



INTERMEDIATE

Objectives Students will be able to *compute* how much money can be made by recycling aluminum and paper. Students improve their ability to *solve math word problems.*

Method Students bring in aluminum cans and *make fractions* and sums based on classifications of cans by product name. Students bring in newspapers. Aluminum cans and newspapers are weighed and calculations are made about how much money can be made by recycling various quantities of these materials at different prices.

Duration: four class periods
Setting: classroom, home
Subjects: Social Studies, Math
Curriculum Reference: 6.3

Preparation ***Aluminum Alert:*** one used aluminum pop can per student, pencils and scales; ***Drowned in Paper:*** paper grocery bags, scales, newspaper brought in from home.

Vocabulary buying price, recycle

Handouts ***Aluminum Alert, Drowned in Paper***

Procedures

1. ***Aluminum Alert:***

   Have each student bring in one clean, empty pop can. (You may want to add more to insure examples of various brands of pop.) Line these up in a long row. Give each student the handout, ***Aluminum Alert***, and have them complete Part A. Discuss answers from Part A and put examples on the board. Point out that aluminum cans are recyclable. Weigh an amount of aluminum cans equal to the number of students in the class. Then, have students complete Part B. If there is a recycling center which takes aluminum in your community, find out what it is paying per pound and substitute for the figure (24¢) given on the handout. Prices can fluctuate between 18¢/lb. to 50¢/lb. so you could make additional math problems for students based on changing the price paid for aluminum. If you are not participating in a recycling collection, donate cans to a group that is. Discuss positive aspects of recycling besides earning money: e.g. saves resources and landfill space.

2. ***Drowned in Paper:***

   Collect in paper grocery bags all newspapers brought into the classroom for a period of two weeks. Give each student the handout, ***Drowned in Paper***, to complete. You will need to help students weigh the newspaper and tell them how many weeks are in your school year and how many classrooms are in your school. When finished, make plans to recycle the newspapers which have been brought to class.

Evaluation Make up additional math questions by varying questions on handouts.

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ALUMINUM ALERT

Part A, Directions: From the row of aluminum cans, make four sums with more than two fractions each. The denominator will be different for each sum depending on the total number of cans you choose to use.

Example: 17 *Coke* cans 9 *Pepsi* 3 *Sprite*

$$\frac{17}{29} + \frac{9}{29} + \frac{3}{29} = \frac{29}{29}$$

1.

2.

3.

4.

Part B, Directions: Answer each question below working your answers out on the back of this page or on a separate sheet of paper.

5. How many cans are there? ____________ How much do they weigh? ____________
6. If each person in the class brought in one recyclable can each school day for a week, and we were paid 24¢ a lb., how much money would the class make?

   In three months? In one week? In one school year?
7. If you collected one recyclable can from every person in Ohio (approximately 10,000,000 people in Ohio), how much money could you make?

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DROWNED IN PAPER

Directions: Answer each question below and show your work.

1. What is the total weight of classroom newspaper? __________ lbs.

2. If we collect this in two weeks, how much would we collect in one school year?

3. If each classroom in the school collected this weight in two weeks, how much would our school have:

   in two weeks? __________

   in one school year? __________

4. What is the best thing to do with old newspapers? ________________

5. If a recycling center will pay 1/2¢ (.5¢) for a pound of paper how much can your class make:

   in one month? __________

   in one year? __________

6. How much can your school make:

   in one month? __________

   in one year? __________

DOLLARS AND POUNDS

CHAPTER 13

COMMODITIES MARKET
GOLD
SILVER
BAUXITE

INTERMEDIATE

Objectives Students will be able to: (1) *explain* why some recyclable materials have a higher market value than others; (2) *calculate* how much money can be made by selling recyclables to a recycling center. Students will improve their abilities to *interpret information* and to *compute figures*.

Method Students define words related to recycling and discuss the value of recyclables based on scarcity and demand. They identify information from a chart to decide scarcity and values of various recyclable materials, and to deduce prices for various quantities of these materials.

Duration: seven or eight class periods

Setting: classroom, home

Subjects: Social Studies, Language Arts, Math

Curriculum Reference: 6.3

Preparation paper, pencils, graph paper, index cards, calculators; if possible, a variety of waste objects made from glass, paper, aluminum, brass, copper, gold; references such as encyclopedias

Vocabulary buying price, market, recycling, scarce

Handouts ***Recycling Market Vocabulary; Money For Recyclables***

Procedures

1. Give each student a copy of the handout, ***Recycling Market Vocabulary***, and have them complete it. Discuss answers.
2. Give each student the handout, ***Money For Recyclables***. Tell each student to look at the chart and list the six material resources according to their monetary value by weight. Make a list on the board for students to rank.

		Answers:
Most Valuable:	1.	(gold)
	2.	(copper)
	3.	(aluminum)
	4.	(brass)
	5.	(glass)
Least Valuable:	6.	(paper)

Ask students why gold is worth more than paper? (Gold is scarcer than wood and there is a big demand for gold as a store of value and to make products.)

3. Introduce the idea of *demand* as another reason for the value of a resource material. If people did not want to drink soft drinks out of aluminum cans, then there would be less value in aluminum as long as the demand for other aluminum products remained constant. If paper mills start using more virgin wood chips than recycled paper to make new paper, then the demand, and hence the price paid to recyclers for recycled paper, goes down. This principle is often why some recyclers quit accepting certain materials, at least until the market value increases.
4. Have students look at the list of material resources identified on the handout, ***Recycling Market Vocabulary***. Tell them to take this list home and look for as many items as possible which are made of these materials. Have students record each item according to which material resource category it fits into and to bring a chart recording this information to school. Have

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students make a chart as follows before leaving school:

Gold	(watch)
Copper	(water pipe)
Aluminum	(pop can)
Brass	(door knob)
Glass	(bottle)
Paper	(plate)

Before students take the chart home and begin their search, have students infer, on a sheet of paper, which material they think they will find the most of, the second most of, etc., to the material they think they will find the least of. Collect these.

5. When students return, discuss their homework charts and check to see if they confirmed their inferences. Discuss why certain material resources seem to be wasted more than others, and discuss how most of the items they identified at home could be recycled in one way or another.
6. Discuss with students how money can be earned by collecting and taking these items to a recycling center (gold is usually taken to a pawn shop or a collector). Prepare index cards with one of the following items on each card. One at a time have students draw a card and use information from the chart, ***Money For Recyclables***, to find how much money they could make if they took the quantity of the item on the card to a recycling center offering the prices designated on the chart.

    1. 24 aluminum cans
    2. 0.5 oz. copper pipe
    3. 43 aluminum cans
    4. gold chain weighing .0008 oz.
    5. 431 aluminum cans
    6. 1 lb. 2 oz. copper wire
    7. 14 lb. glass bottles
    8. 43,100 aluminum cans
    9. 0.5 oz. copper bracelet
    10. 69 aluminum cans
    11. 35.33 lb. newspapers
    12. 2 lb. 6 oz. brass pipe
    13. 150 lb. glass bottles
    14. 400 lb. newspapers
    15. 6 lb. 11 oz. brass light
    16. 86 aluminum cans
    17. 133.33 lb. newspapers
    18. 3 lb. 5 oz. brass planter
    19. 50 lb. glass bottles
    20. 1 lb. 14 oz. brass door knob
    21. 259 aluminum cans
    22. .000048 oz. gold bracelet
    23. 24 aluminum cans
    24. 43,100 aluminum cans
    25. .008 oz. gold ring

7. Check with a local recycling center in your area to find what materials and items they collect. Compare their prices with those on the chart.
8. Initiate a recycling collection drive and have students record how much they make or have made from taking the items to a recycler.

Evaluation Answer the following question: What are the advantages and disadvantages of collecting aluminum for money rather than collecting copper for money. (Possible answer: Aluminum is easy to locate but lower in profit. Not all recycling centers accept copper.) Continue by making additional comparison questions of this type for students.

RECYCLING MARKET VOCABULARY

Part A, Directions: Read the following list of words and put them in alphabetical order.

gold, recycle, copper, aluminum, scarce, brass,
center, resources, litter, demand, glass, paper

1. ________	5. ________	9. ________
2. ________	6. ________	10. ________
3. ________	7. ________	11. ________
4. ________	8. ________	12. ________

Part B, Directions: From the words above find the six items that represent specific materials. Look up and define each word telling where each material comes from and from what resource(s) it is made. Then think of some products made from these materials and list them. Do this on a separate sheet of paper and then answer the questions below.

1. Which of the six materials are renewable, which are non-renewable? (Look up the words *renewable* and *non-renewable* if you do not know them.)

2. What does the word *scarce* mean? Which material listed above do you think is the most scarce? Which is the least scarce? Why?

____

____

____

3. Which two words from the list of 12 words above go together to designate a place? What is this place? What happens at this place? (Describe on back.)

MONEY FOR RECYCLABLES*

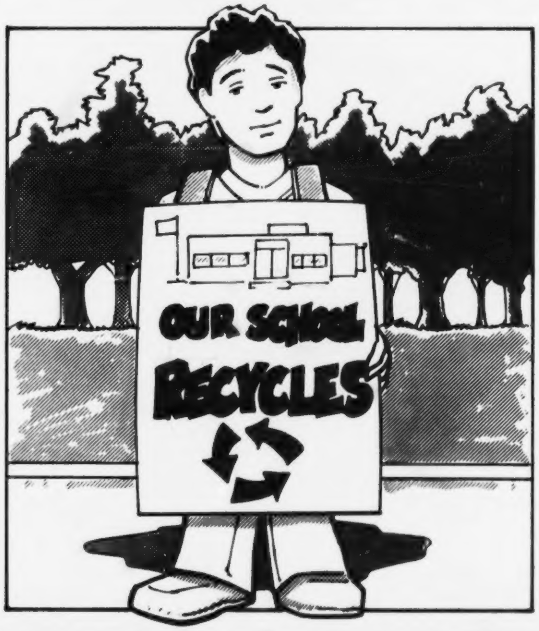
DOLLAR AMOUNT	ALUMINUM 28¢/lb. 24 cans = 1 lb.	BRASS 15¢/lb. .009¢/oz.	C 4 .
$500.00	42,857	3,333.33	11
$100.00	8,571	666.67	2
$50.00	4,286	333.33	1
$5.00	429	33.33	
$3.00	257	20.0	
$2.00	171	13.33	
$1.00	86	6.67	
.80	69	5.33	
.50	43	3.33	
.28	24	1.87	

90.48	.08	66,666.667	2,500
38.1	.016	13,333.333	5,000
19.04	.008	6,666.667	2,500
11.91	.0008	666.667	250
7.14	.00048	400.000	150
4.76	.00032	266.667	100
2.38	.00015	133.333	50
1.91	.00013	106.667	40
1.19	.00008	66.667	25
0.67	.00005	37.333	14
OPPER 2¢/lb. 03¢/oz.	GOLD $6,262/lb. $91.40/oz.	NEWSPAPER 3/4¢/lb.	GLASS 2¢/lb. 0.125¢/oz.

Prices according to Cartwright Recycling – Athens, Ohio; June, 1987.

OUR SCHOOL RECYCLES

CHAPTER **13**



PRIMARY INTERMEDIATE

Objectives

Students will be able to: (1) *describe* and plan a school recycling drive; (2) participate in a recycling drive. Students will improve their abilities to *plan* and to *cooperate with others*.

Method

Students discuss the need to recycle and advertise a school-wide recycling drive in various ways to various grade levels. They conduct a recycling drive with help of parents. They *analyze* their own participation and the process order of things needing to be done in order to conduct a recycling drive.

Duration: several class periods during a week, continuing at various times throughout the year

Setting: classroom, school, home, community

Subject: Social Studies, Language Arts

Curriculum Reference: 6.2

Preparation

Need to have a recycling center in your community and teachers who are willing to donate time to the program. Check with your local recycling center for educational materials or resource people to speak to your class.

Vocabulary

profit, recycling drive

Handout

Time Order of a Recycling Drive

Procedures

1. Students write plays and puppet shows to present to different grades at the school. The class is divided into groups and each is assigned a different grade level. They then create and produce a play or puppet show to encourage everyone to recycle. Ideas for these plays and/or puppet shows can be found in the Chapter 11 activities: **RECYCLING DRAMAS** and **PUPPET DRAMAS**.

2. Throughout the year make posters, write announcements and newspaper articles, and write poems and stories promoting the recycling program. (See other activities in Chapter 11.)

3. The recycling program can begin the first Saturday of October and continue throughout the school year. Call these "Recycling Saturdays." From 9:00 to 11:00 am the elementary school is the collection center. Everyone is encouraged to bring in their newspapers and aluminum cans (or even glass, plastic, oil, etc. — whatever your local center takes). By bringing recyclables to the school on Saturdays only, you eliminate the problem of storing items until it is time to take them to the recycling center. The teachers take turns being on duty for a Saturday. At 10:45 have parent volunteers, along with their children, come to school and load up the pickup trucks, vans or station wagons. Take items to the recycling center. The teachers, parents and students all help unload and learn first-hand how recycling is done. You could go home with a check of $50.00 - $100.00. Use sample exercises from the activity, **ECOLOGY CASH**, in this chapter, to figure profits and potential profits for the school.

4. Monday morning start all over again by making an announcement about "Recycling Saturday" and encouraging everyone to keep saving and collecting. The money earned during the year can be used for educational materials, outdoor education camp, playground equipment, donations to a charity. Let students brainstorm uses for the money. But remember to promote

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recycling as environmentally important as well as a way to make money.

5. After the program has been conducted for a couple of months: a. have students evaluate in a paragraph how they used their own resources in the recycling program (time, equipment, talents, energy, etc.). b. have each student describe in a paragraph how the recycling program resembles a business enterprise including elements of planning and initial investment of time and money, marketing and advertising, recruiting labor, providing services, making a profit, investing the profit, etc.

Evaluation Once the program has gotten underway, have each student define seven to ten steps in sentences which describe what the school is doing. Have students put these in the order they take place. You may use the handout, ***Time Order of a Recycling Drive,*** if it fits your situation.

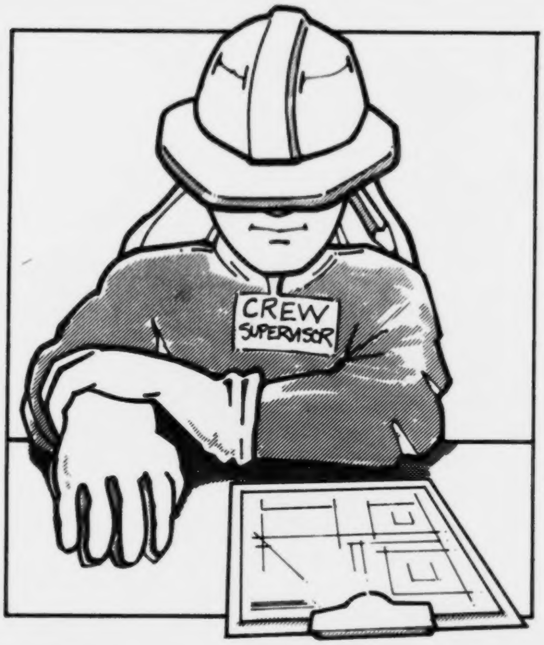
TIME ORDER OF A RECYCLING DRIVE

Directions: To explain what happens in a special effort like a recycling drive, good paragraphs are written in a process order. They tell what happens first, second, third, and so on. Rewrite this paragraph about a school recycling drive in its correct time order.

At 10:45 am parent volunteers come to school and we load up their pickup trucks, vans and cars and depart to the recycling center. Our school recycling program begins on the first day of school. People bring in their newspapers and aluminum cans at this time. From 9:00 to 11:00 am the elementary school is the collection center. We begin studying about recycling and how it helps the environment. We collect anywhere from $50.00 to $200.00 for our newspapers and aluminum cans. After studying about recycling we begin our advertising campaign. Our first "Recycling Saturday" is the first Saturday in October and will continue throughout the school year. At the recycling center we unload and learn first-hand how recycling is done.

CAREERS IN WASTE MANAGEMENT

CHAPTER 13



INTERMEDIATE

Objectives Students will be able to: (1) *describe* the variety of vocations and tasks necessary to operate waste management and recycling concerns; (2) *explain* how these vocations are interdependent. Students will improve their abilities to *cooperate in groups* and to *find information*.

Method Students brainstorm in groups and list vocations and tasks necessary to run waste management and recycling operations. They conduct research to expand on these initial inferences of the group. They use a handout listing numerous job descriptions in different ways to learn more about specific vocations related to waste management.

Duration: five to six class periods

Setting: classroom, community

Subjects: Social Studies, Science, Language Arts

Curriculum Reference: 6.4

Preparation reference books, writing materials, index cards, scissors, glue

Vocabulary careers, industry, interdependent, needs, recycling, task, vocation, waste management

Handout ***Jobs To Be Done***

Procedures

1. Make two headings on the board: one *Waste Management* and the other *Recycling*. Have students think of different needs which communities have related to these concerns: e.g. collection, disposal, separation of materials for recycling, someone to run machines, etc. List in the two columns.

2. Have students divide into groups; some groups are to brainstorm about recycling vocations and others about waste collection and disposal. Each group should make a list in two columns down a sheet of paper. In one column they are to list "general vocations" they think are needed in either waste management or recycling, e.g. engineer, chemist, advertiser, technician (machine operator), laborer. In the space directly opposite each of these, in the other column, they are to describe what "specific tasks" would be required of these vocations in waste management or recycling operations, e.g. engineer - design a landfill; chemist - test sewage water to make sure it is safe to dispose of in the environment; advertiser - make public service announcements telling people to recycle; technician - drive bulldozer at a landfill; laborer - run machine to crush cans at a recycling center. You may want to give students a list of "general vocations" and have them research these in reference sources, looking up the general vocation title. Then they could look up information under headings related to waste management and recycling so as to identify specific tasks.

3. When these lists are completed, discuss the interdependence of each vocation or other vocations and what services are being provided to the community by people who work in waste management and recycling.

4. The handout, ***Jobs To Be Done***, is for you to use in whatever way you wish; but note, there are many terms related to waste management which may need to be explained to students if not done so in the previous exercises. Five suggestions for using the handout follow:

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sources: Brenda J. Green, Summit Elementary (Summit Station, Oh), Mary Jo Powell, Hunter Elementary (Franklin, Oh) and Lisa Curran, DLPR.

- After groups have discussed their own research, compare with the handout, having them make additions. (Also, note that not all vocations or concerns related to waste management and recycling are listed on the handout, e.g. waste incineration plant and operator, and remanufacturers of paper, aluminum and plastic.)
- Make a list on the board of the general headings in the handout; *Collection, Landfill Disposal, Recycling Collection, Recycling Manufacturing,* etc. Have students divide into groups for each heading, and using references, have them make reports on what jobs are required to run a waste collection company, a landfill, a recycling center, etc. Then, have them compare their answers with the handout.
- Give each group a copy of the handout and go over it. Have students decide what vocation(s) they would like to pursue and explain why.
- After going over the handout with students, make a role playing game. Have students cut out job descriptions from the handout and paste or glue or tape onto index cards. Mix the cards up in a box and have students take turns drawing job descriptions from the box and acting out a charade to see if their group can guess the specific vocation and task involved. The group that makes the most correct answers wins a prize.
- Use cards with job descriptions (as made above) in a classification exercise. Write the general headings from the handout on the board. As each student takes a card they should read the description out loud and identify under which category the job fits. You could divide the class into teams for this. (Note that some job descriptions may fit more than one general category, so have students explain their answers.)

Evaluation

1. Take a field trip to a recycling center, a landfill, a recycling manufacturing plant, etc. Have students identify as many jobs as they can based on what they observe.
2. Have students look at pictures in the handout, ***Machines and Systems***, in the activity, **CHANGING MATTER IN ANALOGOUS WAYS** (Chapter 14), and identify what machines and tasks are required to run specific operations, e.g. collection, recycling center, a landfill, etc.

COLLECTION

SANITATION DISTRICT SUPERVISOR: responsible for planning, directing and coordinating collection and disposal of refuse in a district of homes and/or businesses.

REFUSE COLLECTION SUPERVISOR: oversees the work of a crew of drivers; assigns routes to pick up trash; checks for completion of each job; handles problems with the collection crews and complaints from people on the route that have their garbage picked up.

REFUSE COLLECTION DRIVER: drives a packer truck (rear loader with compactor) and supervises two refuse collectors, called *ground men*.

AUTOMATED REFUSE VEHICLE OPERATOR: operates automated refuse collection vehicle that picks up and empties special waste containers with a lift device on the outside of the truck; use front loaders to empty dumpsters; use side loaders for 90- or 300-gallon containers.

REFUSE COLLECTOR (also called *ground men*): collects waste in an assigned area of the city by dumping it into a packer truck as they follow behind the truck. (Some companies are in the process of phasing out this job due to personnel costs — with new technology, it is cheaper to use automated trucks, the use of which also decreases injuries.)

CUSTODIAL WORKER: cleans buildings and maintains grounds so that waste collection does not create health problems for fellow workers or people living near by.

REFUSE CONTAINER ASSEMBLER AND REPAIRER: puts 300-gallon containers together, places them in neighborhoods and repairs them; keeps track of supplies needed to prepare/repair many types of containers; drives truck that spray-cleans the containers.

SAFETY PROGRAM MANAGER: investigates accidents and injuries; prepares safety program for employees.

DATA PROCESSOR: puts office data, job functions, etc. on computer.

SECRETARY: keeps records, types correspondence and other things for supervisors.

DISPOSAL: LANDFILL OPERATIONS

ADMINISTRATOR: oversees, develops and maintains the disposal site, therefore must have engineering experience (i.e. drafting, construction, design, etc.); is appointed by county commissioners.

SUPERVISOR OF MAINTENANCE: takes care of grounds (lawn, landscape, etc.); inspects contract operations and incoming waste so that unacceptable waste (could include hazardous materials or materials that can be recycled) are not taken to the fill area.

OFFICE MANAGER/ACCOUNT CLERK: in charge of business functions, money spent and received; keeps track of who works at the company and how many hours each person has worked each week; writes letters and answers questions from the public.

JOBS TO BE DONE

MANAGER: supervises disposal site and workers; makes sure that operations at the fill area are done right; must have education and/or experience in engineering.

BULLDOZER OPERATOR: drives a tractor with a large, shovel-like blade on the front to move earth to make room for waste dumped by collection trucks.

COMPACTOR OPERATOR: drives a tractor that compresses trash to save room at the disposal site.

SCRAPER OPERATOR: drives a vehicle with a large bed for dirt; removes dirt from one area and places it somewhere else.

GRADER OPERATOR: drives a machine with a long shovel to smooth out roads and land areas leading into and out of the disposal site.

WATER TRUCK OPERATOR: drives a truck with a big rectangular 3,500 gallon bed for water (called a roll-off); used to wet the roads to control dust.

MAINTENANCE LABORER: maintains the area around the disposal site to make it safe and healthy for the community; operates a sweeper tractor and dump truck to clean up grounds.

MECHANIC: checks the heavy equipment to make sure that everything is working right to prevent accidents; keeps track of the parts needed to fix the equipment; repairs equipment.

SECRETARY: answers the phone and writes letters to answer questions; keeps the office neat and running smoothly; helps pay the bills and keep track of money owed.

RECYCLING COLLECTION

MANAGER: keeps operations running smoothly; supervises employees and pay backs to people bringing in items.

METALS BUYER: buys scrap metal (includes non-ferrous items such as aluminum, copper, and brass) from industries, junk yards, etc.

OPERATOR/LABORER: takes cans and other materials from the people who bring in these items; takes the collected materials to the hopper; operates the machines which pack and bale the materials.

RECYCLING MANUFACTURING
(Example of a Glass Plant)

PLANT MANAGER: makes sure all operations are running smoothly at the plant, including orders for materials, work operations and shipping of final product.

PERSONNEL OFFICER: maintains employee records, benefits, hiring and hours of labor; conducts tours of the glass plant facility, providing a history and question and answer period before and after the tour.

MACHINE OPERATOR: runs machines that mold glass into bottle shapes; makes sure machines are running properly, weighs and checks bottles at random about every 1/2 hour to be sure they meet specifications.

MACHINE MAINTENANCE: in charge of major maintenance on machines; must go through apprentice program for four years or 4000 hours due to the complexity of the machinery and the importance of it running efficiently and safely.

BATCH FOREMAN: runs furnace; orders raw materials.

MOLD MAKERS: make specific molds, e.g. perfume bottle molds, to put on machines for special jobs.

QUALITY INSPECTOR: checks each finished product under a light for defects in the glass; checks each opening to be sure it is the proper size.

PACKAGE ASSEMBLER: assembles boxes to package final products which include a variety of shapes of jars and bottles requiring different boxes.

FORKLIFT OPERATOR: transports packaged item to the warehouse in preparation for shipping.

WAREHOUSE WORKER: keeps track of inventory; in charge of shipping and receiving materials.

LAW ENFORCEMENT

LAW ENFORCEMENT ASSISTANCE COORDINATOR: works with police departments to hire officers to enforce litter laws; provides information to the officers who have the special assignment of litter enforcement.

LITTER LAW ENFORCEMENT OFFICER: enforces litter laws after special training; a typical day includes talking with people who complain about litter, making sure people don't dump their litter along the road or on someone else's property. They watch for trucks that might lose materials because they are overloaded or uncovered. They find out where, when, how, and who littered by taking samples of litter, writing reports, and arresting the person when found.

ENVIRONMENTAL COURT JUDGE: listens to cases dealing with environmental issues, including pollution, hazardous waste, and the transport of wastes; assigns fines and/or punishment to those found guilty.

LAWYER: concerned with legal aspects of recycling wastes and disposing of waste so that those accused of breaking the law are defended until they are found guilty or innocent before a judge; requires a lot of knowledge about law and the environment.

MISCELLANEOUS

WASTE SYSTEMS MANUFACTURER: makes and sells equipment which can be used at recycling centers and at waste management facilities.

CONSERVATION CONSULTANT: helps public/private agencies set up containment and source separation systems as part of a solid waste management plan which includes recycling.

PUBLIC AWARENESS

WRITER/JOURNALIST: responsible for written and oral communication, including presentations, writing letters to answer questions from the public, writing stories and articles about waste problems for publications.

PUBLIC RELATIONS SPECIALIST: coordinates special/public events about waste problems, recycling opportunities and litter cleanup campaigns; works with television and radio stations to make public service announcements.

EDUCATION

EDUCATION SPECIALIST: develops activities/programs for teachers and schools to use when teaching about the environment, ecology and waste problems in their community.

TEACHER: teaches children about ecological and environmental issues by providing opportunities for them to develop skills necessary to do all the jobs related to waste management listed on this handout.

Chapter 14

Machines to the Rescue

THE GREAT CAN CRUSHER CONTEST

CHAPTER **14**

TOOLS
NAILS

INTERMEDIATE

Objectives

Students will be able to: (1) *describe* the type of simple machines and forces required to compact recyclable cans; (2) *explain* the purpose of compacting materials. Students will improve their abilities to *manipulate materials with tools* and to *solve mechanical problems.*

Method

Students *cooperate in groups* to develop and implement plans to build a can crusher from a variety of construction materials brought into class. Machines are tested and judged. Students *write* an evaluation of the procedure.

Duration: five to six class periods

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 1.6, 1.7

Special Note: This activity is compatible with initiating a recycling drive for aluminum cans at your school. The activity itself will draw attention to the drive and the projects made will aid in the storage of cans before they can be taken to a recycler.

Preparation

Several weeks prior to conducting this activity, have students begin bringing in the following materials: rope, wire, hinges, screws, nails, wood scraps, bricks, blocks; any type of construction item on hand; the following tools if these cannot be supplied at school: hammer, saw, screwdriver, pliers, wire cutters, aluminum cans. Read over the activity so you will gain a sense for materials that may be useful and items which would not. You may want to seek help in acquiring materials, as well as guidance, from the industrial arts teacher in your school or in a school close by within the system. Parents or other community members may be helpful for obtaining materials. For safety's sake, you should have students construct their projects in a shop room (where tools may also be readily available) and have parent volunteers or others on hand to supervise. Also useful in this activity, for Steps 2 and 5, are pictures of waste management machines, particularly can crushers and compactors, which can be found in the handout, ***Machines and Systems***, in the activity, **CHANGING MATTER IN ANALOGOUS WAYS**. You may want to have copies of these on hand for each group.

Vocabulary

compaction, forces, process sequence, simple machines, work

Handout

Can Crusher Production Method

Procedures

1. Organize the class into several groups. Explain how various simple and compound machines make work easier.

2. Show the students four clean empty aluminum cans. Ask a volunteer to crush three of the cans with his or her foot. Then compare the space taken up by three crushed cans with the space taken up by the uncrushed can. Discuss how *compaction* is important for home storage and for recyclers (less storage space required, easier and cheaper to ship). Discuss the work needed to be done to crush a can. Show students the pictures of can crushers on the handout, ***Machines and Systems***, in the activity, **CHANGING MATTER IN ANALOGOUS WAYS**, found in this chapter. Have students identify what is involved. (Perhaps you could take a field trip to a

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recycling center and have the guide explain what a can crusher or can crusher/baler does.) Discuss the nature of simple and compound machines in your textbook and identify which ones could be used to crush a can.

3. Examine materials brought into class. Give each student in each group the handout, ***Can Crusher Production Method***. Allow time (perhaps several days) for each group to work on each stage of the process. They may think of more materials (which can be brought in at a later time) to help improve their machine once the construction phase is begun. Make students aware of the categories to be judged in regard to their machines ("IV. Contest" on handout).
4. Hold contest and judge the entries.
5. Expand on the concept of machines and waste by using the handout, ***Machines and Systems***, in the activity, **CHANGING MATTER IN ANALOGOUS WAYS**. Put the following list on the board: "Waste Collection," "Landfill Operation," "Recycling Center," "Waste Incinerator." Explain each subject briefly. Then, have students identify on a sheet of paper, by name of machine (designated on handout), which machines and systems are part of which of the four categories listed. Following a discussion of answers, have students identify simple and compound parts of the machines, often by inference based on what they think must be going on inside the machine. (For a brief description of what each machine does, refer to the handout, ***Systems of Organs and Machines***, in the activity, **CHANGING MATTER IN ANALOGOUS WAYS**.)

Evaluation

Have students refer to the outline handout, ***Can Crusher Production Method***, and write an evaluation of the entire process as they experienced it in their groups, noting which steps were easiest or hardest and explaining why. Also, have students explain what types of forces (push, pull, up, down) and structural elements make up the functioning of their invention.

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CAN CRUSHER PRODUCTION METHOD

I. Design Phase

A. Discuss different types of designs by thinking about simple machines or combinations of machines which could be made from the materials brought to class.

B. Draw a rough sketch design of the machine which everyone in the group can agree on. Make a list of items which are needed to make the machine. Make sure these items can be found at school or brought in from home.

C. Write an explanation of how the crusher works. Identify simple machines (i.e. lever, pulley, screw) and the direction of forces.

II. Construction Phase

A. Draw and label the exact dimensions you want the can crusher to be.

B. List materials needed for crusher and tools needed for assembly.

C. Plan assembly order. (How do you put it together: in what sequential stages?)

D. Construct the crusher according to your design.

III. Test Phase

A. Test crusher and repair or redesign any flaws.

B. Write step by step instructions for using can crusher.

IV. Contest

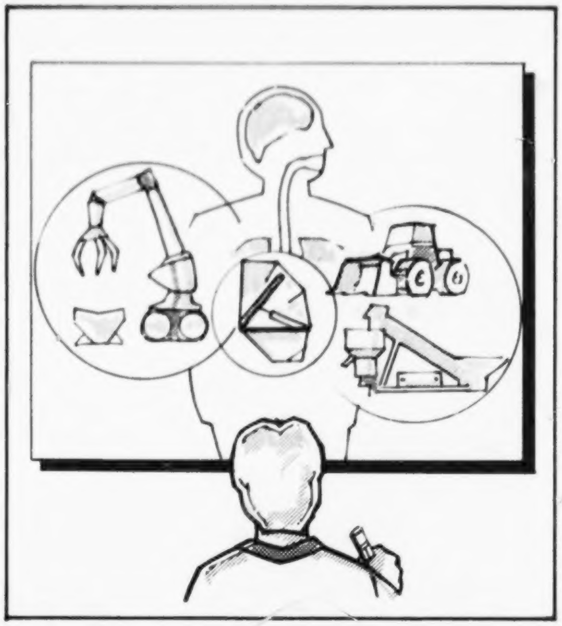
A. Design Award:

a. Novel Award (most unusual machine)
b. Complex Award (machine made up of the most simple machines)

B. Efficiency Award: Takes least work (energy) to crush a can

CHANGING MATTER IN ANALOGOUS WAYS

CHAPTER 14



INTERMEDIATE

Objectives

Students will be able to: (1) *identify* recycling and waste management machines and systems; (2) *explain* how this technology changes waste materials. Students will improve their abilities to *make inferences* and *analogies* and to *conduct research*.

Method

Students, by using information and pictures in health books and handout material, make inferences about analogies between human body organs/systems and waste management machines/systems. They research analogies to confirm their inferences and to explain their analogies in further detail. They explain comparisons by writing descriptions and giving oral presentations.

Duration: four to six class periods

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 1.6, 1.7

Preparation

Before beginning this activity students should already have been introduced to basic concepts of waste management and recycling. Doing related activities in Chapter 4 would be helpful. Check the vocabulary words listed in this activity and cover these ahead of time, or introduce them as you conduct the exercises of this lesson. Needed are: health textbooks, reference sources, writing materials.

Special Note: You may choose to do this activity as an exercise related to waste management technology and leave out the parts which require students to make analogies with human body systems. In this case, Step 3 is the most important.

Vocabulary

analogy, collection, compaction, containment, disposal, energy, incineration, inference, landfill, leachate, magnetism, recovery, recycling center, recycling plant, shred, sort, systems, work

Handouts

Systems of Organs and Machines; Machines and Systems

Procedures

1. Motivate students by asking them what happens to the food they eat and what happens to the containers and food they throw away. Discuss concepts related to digestion and excretion and concepts related to solid waste disposal.

2. Using health textbooks have students point out the distinction between organs and systems in the human body.

3. Have students divide into groups. Give each group a set of illustrations (five pages) on the handout, ***Machines and Systems***. Be sure students understand the distinction between individual machines and systems of machines. Then, have students identify which machines on the handout go with which systems (some may be related to more than one system). This could be done by having each group cut out the pictures of machines and systems and paste them as they relate together on separate sheets of paper. (Remember, in cases where a machine can be used more than once, you will either want to have more copies on hand or have students write the name of the machine with the system for which they have no additional picture.) To facilitate matching machines with systems, you may find it helpful to give each group

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the second part of the handout, ***Systems of Organs and Machines***, which is titled "*SOLID WASTE SYSTEMS AND MACHINES*." Here the functions of the machines and systems are explained. You will need to explain some terms on this handout as students use it in this exercise. After matching machines with systems, have each group make a presentation of their work. Have groups make corrections and then put their displays on bulletin boards around the room for use in the next step of the activity. (To shorten this exercise you could have each group take a different system and identify machines associated with it.)

4. Have students return to their seats. Give each student a copy of the handout, ***Systems of Organs and Machines***. Go over the directions.
5. Give students time to look over the rest of the information on the handout, to look at pictures on the bulletin boards and to compare with information and pictures in their health books. Then, have students write down their inferred analogies. Arrange for more research time to conclude the activity. Students may want to make their own pictures to illustrate analogies related to specific movements or functions.

Evaluation Have each student write an essay explaining comparisons and details of his or her analogy and then explain the analogy orally to the class.

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SYSTEMS OF ORGANS AND MACHINES

Directions: Below are examples of human body systems. On the next two pages of this handout are descriptions of solid waste systems and machines (which match the illustrations on the handout, ***Machines and Systems***). Use this information to identify a relationship between a system or organ of the human body and a system or machine used in waste management and recycling. State this relationship in the form of an analogy in the space provided below (e.g. *Digestive System* is analogous to *Burying Waste System*). Make an inference as to why you think these two systems or organs and machines are analogous by explaining the relationship between the two. Then, using your research skills, confirm your inference and find as many relationships as you can between the two items you have chosen.

______________________ is analogous to ______________________

My inference as to why they are analogous is

____

____

EXAMPLES OF HUMAN BODY SYSTEMS

CIRCULATORY SYSTEM: A network of arteries, veins, capillaries and organs that carry the blood throughout the human body.

DIGESTIVE SYSTEM: A group of organs that work together to perform the function of breaking down food.

ENDOCRINE SYSTEM: A group of glands working together to secrete chemicals into the body to allow for digestion, growth, development and chemical balance of the human system.

MUSCULAR SYSTEM: A group of tissues that function in ways to allow for body movement.

NERVOUS SYSTEM: A network of nerves that receive information from the senses, transmit this information to the brain by way of the spinal cord, and carry a response back to the rest of the body when needed.

RESPIRATORY SYSTEM: A group of organs and body structures that work together to enable the body to breathe.

SKELETAL SYSTEM: A group of bones that work together to support the body tissues and organs and to perform movement.

URINARY SYSTEM: A group of organs working together to rid the body of harmful wastes.

SOLID WASTE SYSTEMS AND MACHINES

Containers and Collectors

COLLECTION VEHICLE: A truck that holds waste collected from homes and businesses; it is then used to haul the waste to a disposal place.

DUMPSTER: A large waste container for apartments, businesses and industries.

KNUCKLE BOOM LOADER: A machine that picks up waste from one source and puts it somewhere else: into another container or into a disposal or recycling system.

SOURCE SEPARATION COLLECTION VEHICLE: A truck that has separate compartments for collecting recyclable materials such as glass bottles and jars, aluminum and steel cans, newspapers and cardboard.

TRASH CAN: A small container for members of a household to put waste in before it is collected for disposal.

Compactors

BALER FOR PAPER AND CARDBOARD: A large machine that compacts paper or cardboard into a bundle and wraps the bundle in wire.

CAN COMPACTOR: A machine found at recycling centers that smashes cans so they take up less space when they are stored or shipped to a manufacturing plant.

CAN CRUSHER: A household device for smashing cans so they can be stored in less space before they are taken to a recycling center.

EARTH COMPACTOR: A big machine with very heavy metal wheels that flattens waste to save space at a landfill by repeatedly running over waste.

HYDRAULIC COMPACTOR: A device used in collection vehicles to smash waste into the bed of the truck to make room for more waste.

Separators, Sorters and Shredders

ELECTROSTATIC PRECIPITATOR: A very large machine that uses electrical charges to separate particles of matter from steam vapors which are created when trash is burned. The clean vapors (gases) then go up a smoke stack while the particles of matter are collected in large buckets.

HYDRAPULPER: A paper recycling machine with a huge tank. In the tank, staples and other tiny objects are separated from recycled paper as the paper is whirled around and mixed with wood pulp and water to be prepared for making new paper.

MAGNETIC SEPARATOR: A machine found at recycling centers which separates aluminum cans from steel cans using a magnetic belt.

SHREDDER: A machine that tears up cans (or other waste material) into small pieces so they will be easier to recycle.

Disposal Systems

BURNING WASTE: A large furnace or series of furnaces called a refuse incinerator is used to burn waste materials. There is a place for the refuse to be dumped; it travels along belts to the furnace where it burns, creating gas vapors and smoke. These vapors rise to go through a filtering device such as an electrostatic precipitator and then go up a smoke stack. Ashes and other residues are collected to be taken to a landfill.

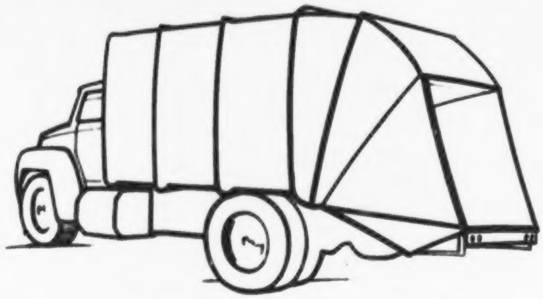
BURYING WASTE: A large area of land called a landfill is cleared so that trash can be compacted and buried by dirt each day. Landfills also have some type of liner, either clay or plastic, underground beneath the trash so that a harmful waste liquid (leachate) does not leak into ground water supplies.

Recovery Systems

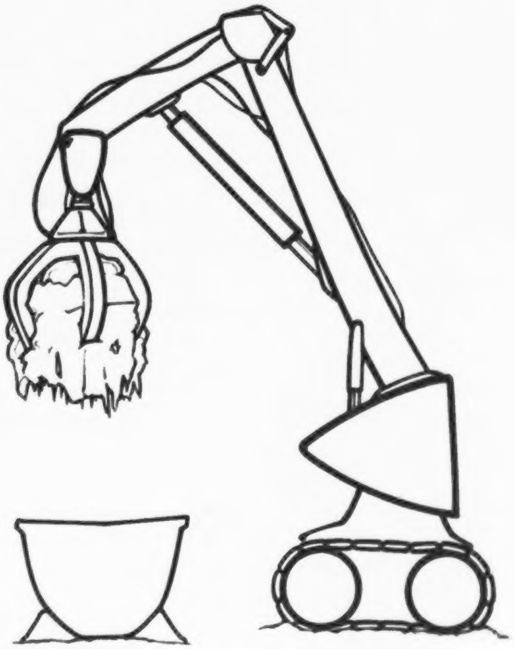
MATERIALS RECOVERY: A recycling system that begins with the collection of materials, such as aluminum cans or glass bottles. These are separated from other materials or sorted by color. Then, aluminum is shredded or glass is crushed into small pieces. The material is sent to a recycling plant where it is transformed, in the case of aluminum or glass, into a liquid (by heat) which is then poured into molds. Aluminum molds cool and the aluminum ingot is used to make new cans at a can making plant. Glass is poured into a mold that gives it the shape of a bottle which then cools into a hard form.

ENERGY RECOVERY: A method of burning waste to obtain energy. It includes collecting waste materials and removing materials that do not burn easily. As the combustible waste is burned in a furnace, the hot gases generated are used to raise the temperature of water inside a large tank until steam is generated. This steam is then used directly for heat or is run through a turbine to produce electricity. As in all refuse incinerators, ashes and residues are left over which must be taken to a landfill. Also, particles of waste in the hot gases which heat the water tank must be filtered by an electrostatic precipitator or other device. This makes the gas safe to go up a smoke stack and into the environment.

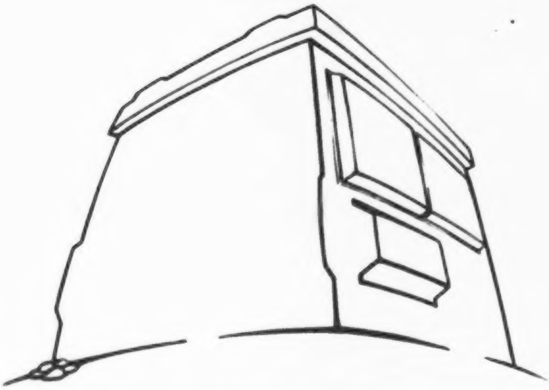
CONTAINERS AND COLLECTORS



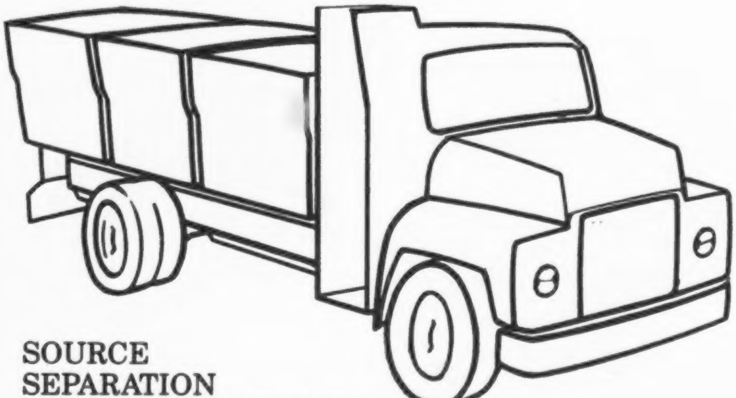
COLLECTION VEHICLE



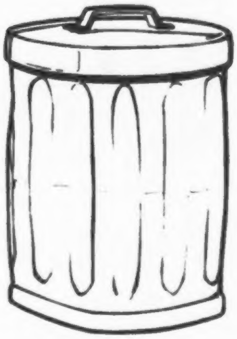
KNUCKLE BOOM LOADER



DUMPSTER

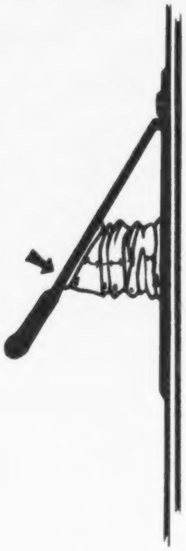


SOURCE
SEPARATION
COLLECTION VEHICLE



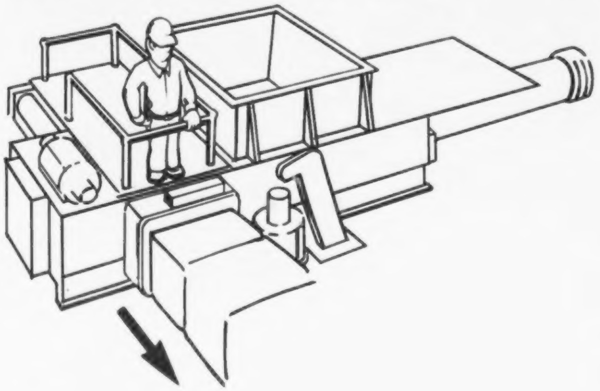
TRASH CAN

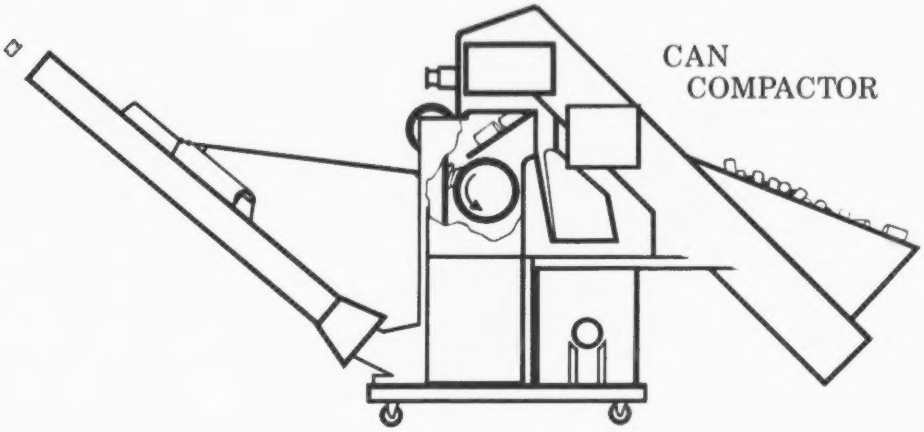
COMPACTORS



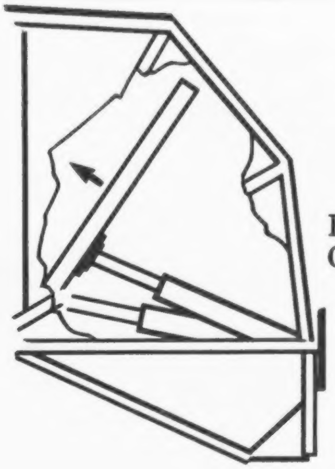
CAN
CRUSHER

BALER FOR PAPER AND CARDBOARD

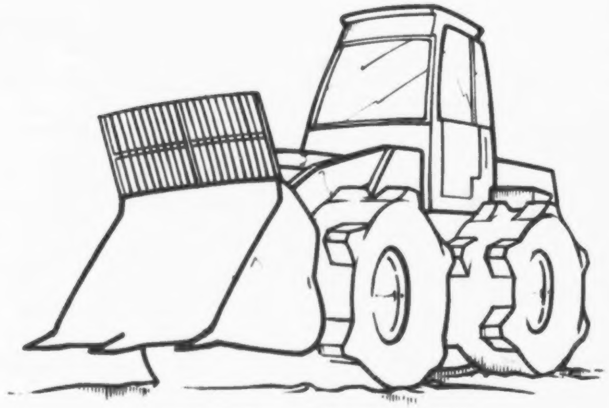




CAN
COMPACTOR

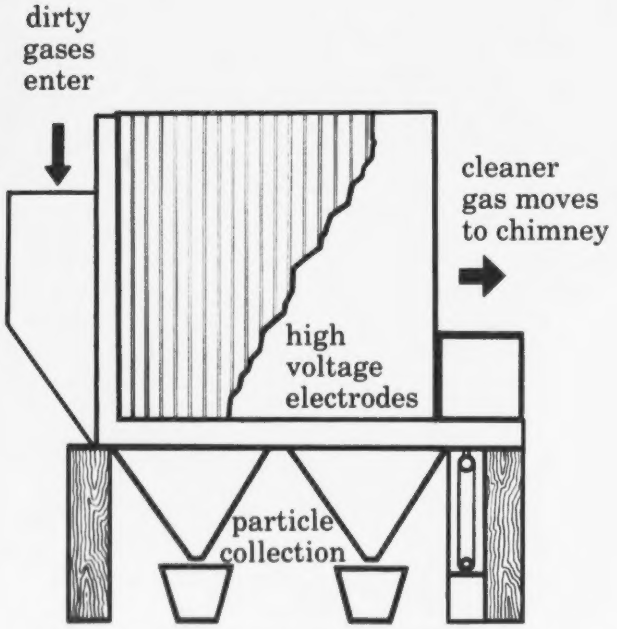


HYDRAULIC
COMPACTOR

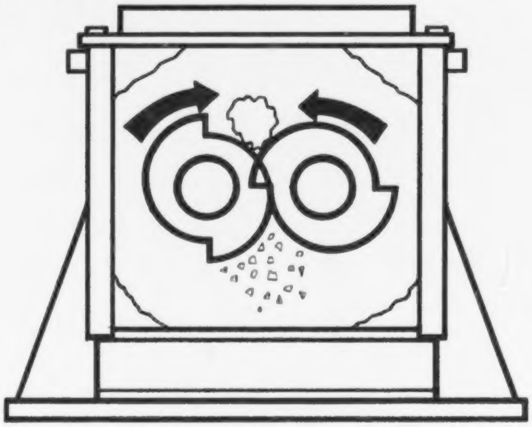


EARTH COMPACTOR

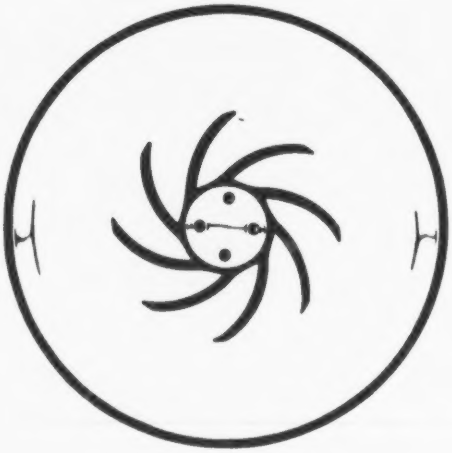
SEPARATORS, SORTERS AND SHREDDERS


dirty
gases
enter
cleaner
gas moves
to chimney
high
voltage
electrodes
particle
collection

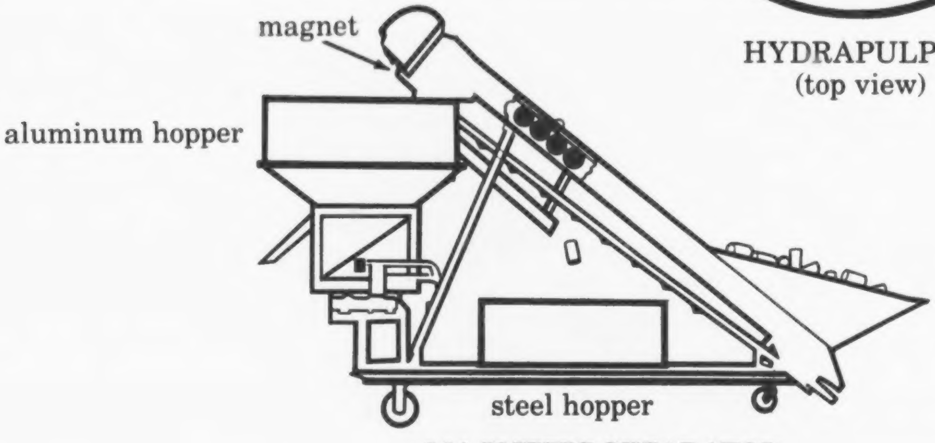
ELECTROSTATIC PRECIPITATOR
(cut-away side view)



SHREDDER
(side view)

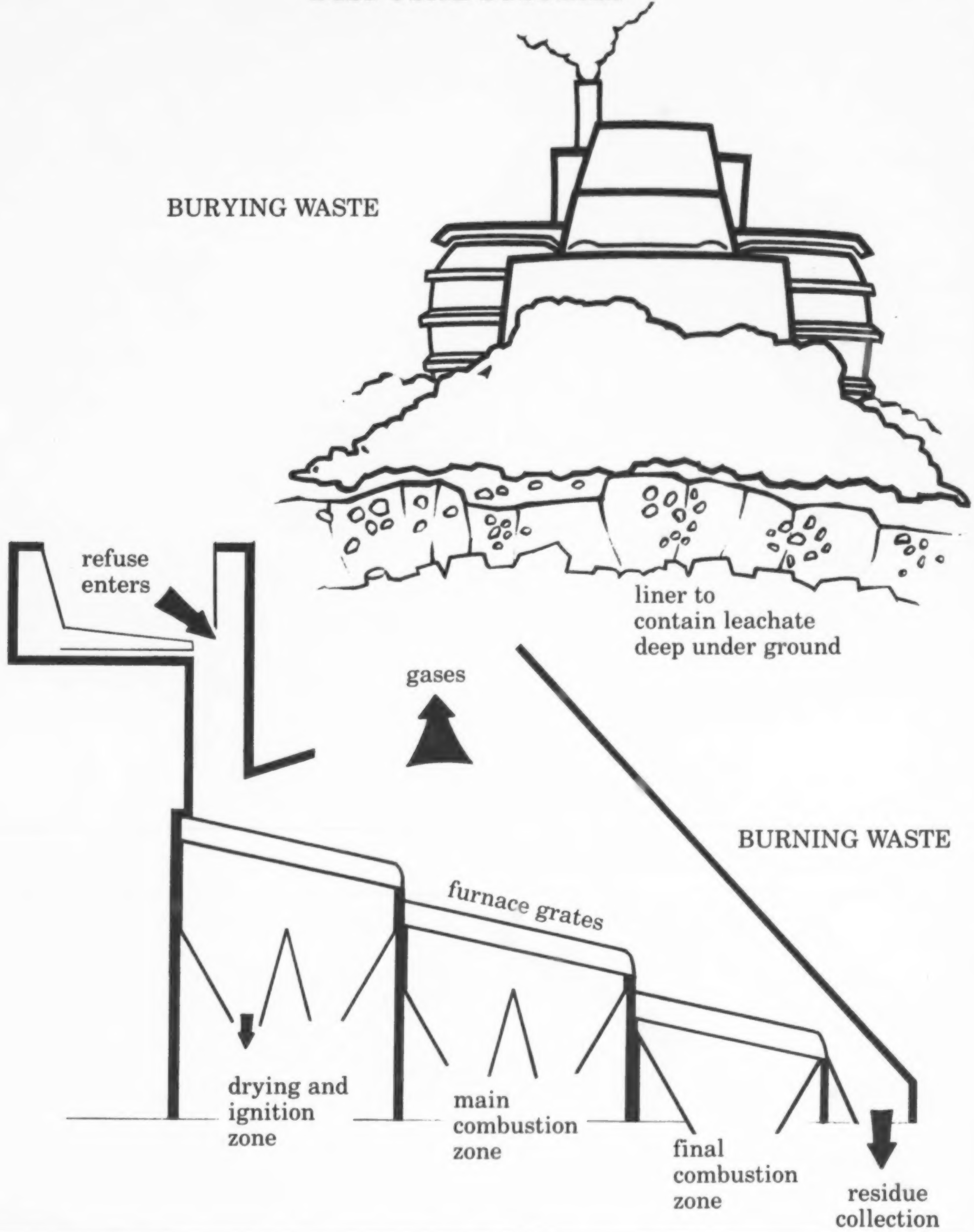


HYDRAPULPER
(top view)


magnet
aluminum hopper
steel hopper

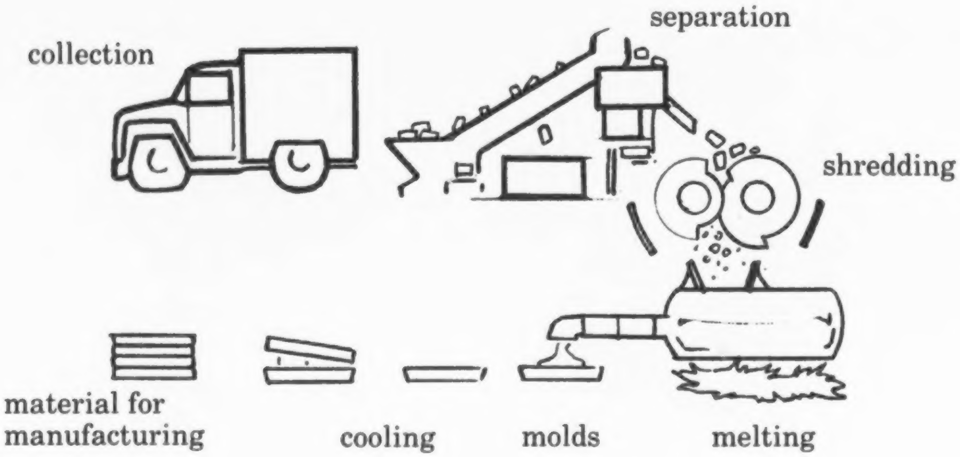
MAGNETIC SEPARATOR

DISPOSAL SYSTEMS

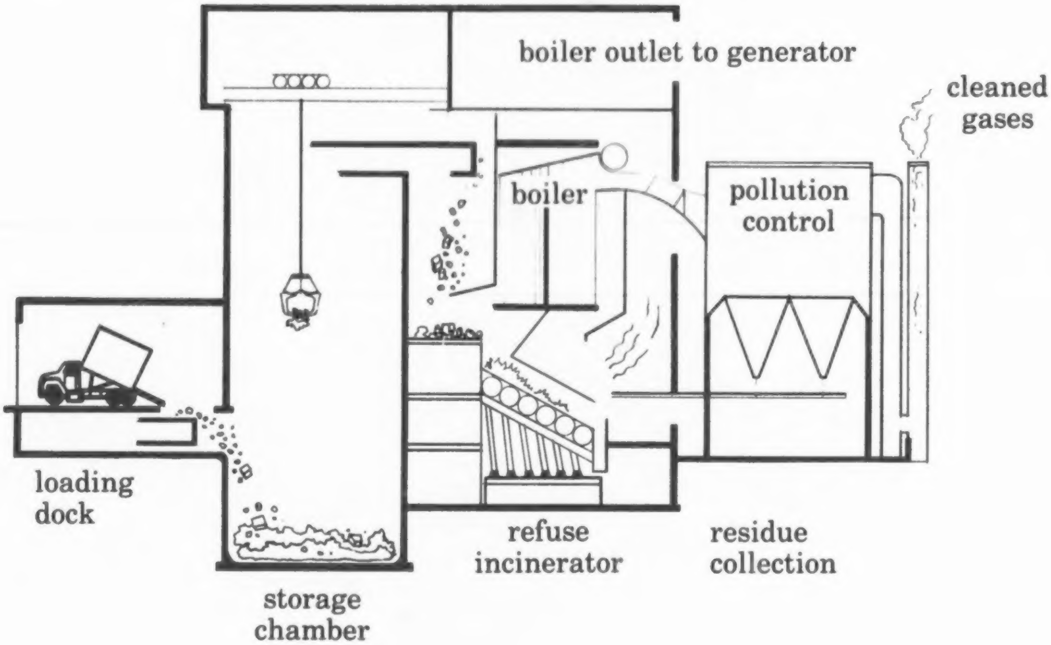

BURYING WASTE
liner to
contain leachate
deep under ground
refuse
enters
gases
BURNING WASTE
furnace grates
drying and
ignition
zone
main
combustion
zone
final
combustion
zone
residue
collection

RECOVERY SYSTEMS

MATERIALS RECOVERY (aluminum)


collection
separation
shredding
material for manufacturing
cooling
molds
melting

ENERGY RECOVERY


boiler outlet to generator
cleaned gases
boiler
pollution control
loading dock
refuse incinerator
residue collection
storage chamber

RECYCLING SYSTEMS MAKE SENSE

CHAPTER 14

INTERMEDIATE

Objectives Students will be able to: (1) *identify* technological processes necessary to recycle materials; (2) *infer* the process order in which machines work in a system to change waste material into reusable material. Students will improve *expository writing skills*.

Method Students *observe* pictures of three systems of recycling machines (for metal, glass and paper) and *interpret* how the machines change the property of objects. They *describe* in process order how machines work as a system by writing detailed sentences that support a main idea sentence about a recycling system. They construct paragraphs.

Duration: seven to nine class periods

Setting: classroom

Subjects: Science, Language Arts

Curriculum Reference: 1.6, 1.7

Preparation Students need writing materials and a basic understanding of descriptive sentences and the structure of a paragraph. Go over vocabulary words before beginning.

Vocabulary ferrous metal, machines, nonferrous metal, recycling, system, technology

Handouts ***Car-Body Shredding Machines; Car Shredding Plant; Bottle Making Machines; A Glass Factory; Paper Making Machines; A Paper Mill; Teacher Information***

Procedures

1. The first activity is a whole group activity. Pass out the illustration handout, ***Car-Body Shredding Machines***, to each student along with the worksheet, ***Car Shredding Plant***. Discuss instructions on the worksheet and allow the students time to complete and write down sentences to explain each picture. Before continuing the activity, you may want to refer to the ***Teacher Information*** where the correct order and explanations of the pictures are presented. Using the blackboard, ask students what machine picture they put first or which one should be first. Then ask for a sentence description of what that machine process does. Do the same until you have written sentences for each step based on consensus of the class. Then ask students to come up with a *main idea* sentence and a *concluding* sentence. As a final exercise, have students copy the sentences from the board in paragraph form. Stress correcting errors during writing and importance of clarity in their descriptions.

2. In the second activity, have students break into groups of three. Pass out the illustration handout, ***Bottle Making Machines***, and the worksheet, ***A Glass Factory***, and review the directions. Students should work in groups quietly to discuss what they think the correct order and explanations of the system of pictures might be. They follow the same procedure as before, writing their ideas down, deciding the correct order, and writing a rough draft paragraph with *main idea* and *concluding* sentences. The final draft is written by each student and turned in to the teacher. Hold a sharing time to compare group answers. Go over correct answers based on the ***Teacher Information*** so students know the actual order and function of each of the machines pictured. If their descriptions differ from the correct descriptions, have them defend their answers and give them positive feedback for logical explanations.

©1988 Ohio Department of Natural Resources; source: John R. Larabee, East Elementary (Lancaster, Oh) and David Landis, DLPR.

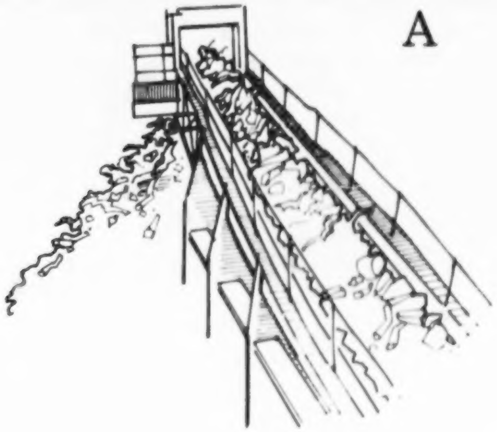
3. The final activity is individual. Pass out the illustration handout, ***Paper Making Machines***, and the worksheet, ***A Paper Mill***, to each student. Discuss the instructions and let students complete the worksheet, rough draft and final draft. The students should be pretty good by now at getting their ideas down on paper. Stress that the final draft should make good sense and be error free. Finally, include a sharing time and present correct order and picture explanation as done before.

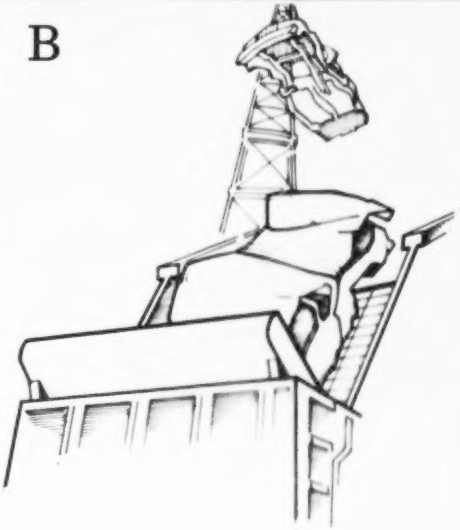
   NOTE: Students may want to use more than one sentence to describe what is happening in some of the pictures.

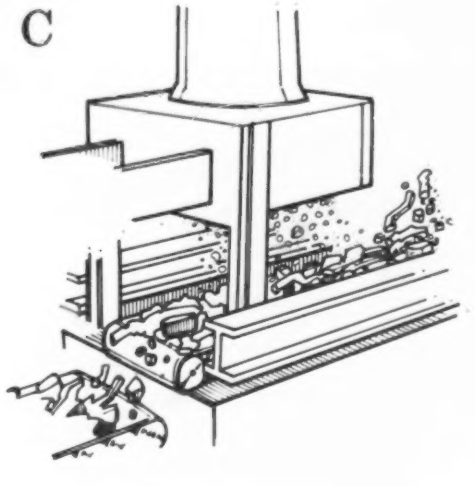
Evaluation

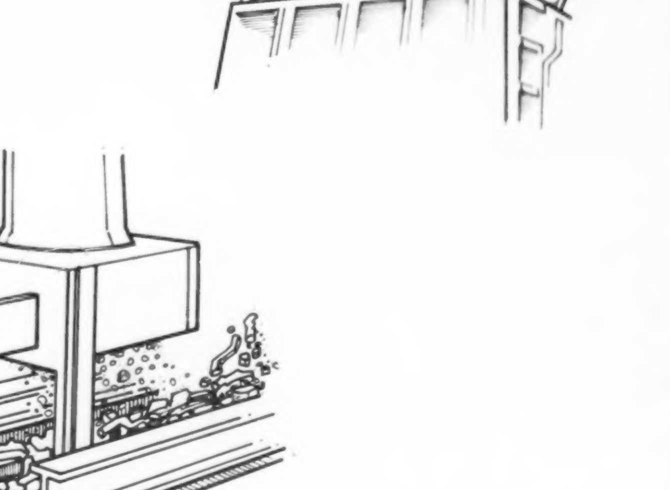
If possible, take students to your local recycling center on an *expository writing expedition* field trip. Have them identify from "drop-off" to "shipping out" the process used to prepare one or more recyclable items (glass, aluminum, paper, etc.) for shipment to a recycling manufacturer. They should take notes of what they see and upon returning to class write descriptive paragraphs, in process order, about the preparation of recyclables.

CAR-BODY SHREDDING MACHINES









CAR SHREDDING PLANT

Directions: Look at the pictures on the handout, ***Car-Body Shredding Machines***. These machines make up a system that changes old car bodies into small pieces of shredded metal. These pieces of shredded metal contain a lot of dirt. Also, there are pieces of ferrous metal and pieces of nonferrous metal that must be separated before they can be shipped to different recycling plants to be used to make new metals. Place the pictures in the correct process order, and write a sentence to describe what is happening in each picture. Remember, even though you do not know exactly what is happening, try to guess. Put the letter of each picture beside the Step number you think it corresponds with in a process order. Then write a sentence describing what you think is happening in the picture.

Step 1 (Picture letter)

Step 2 (Picture letter)

Step 3 (Picture letter)

Step 4 (Picture letter)

Step 5 (Picture letter)

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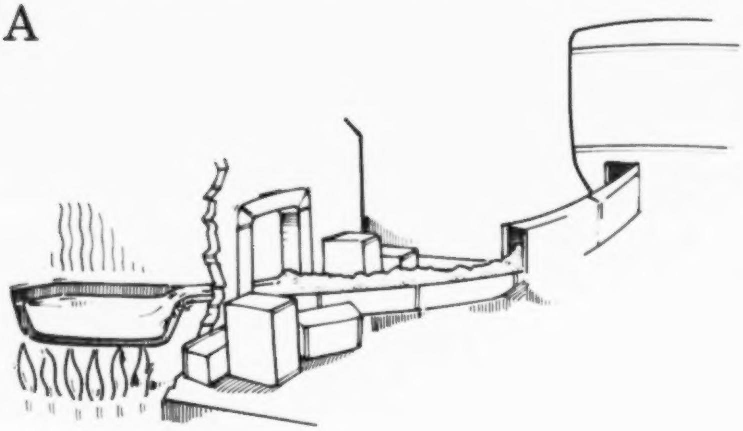
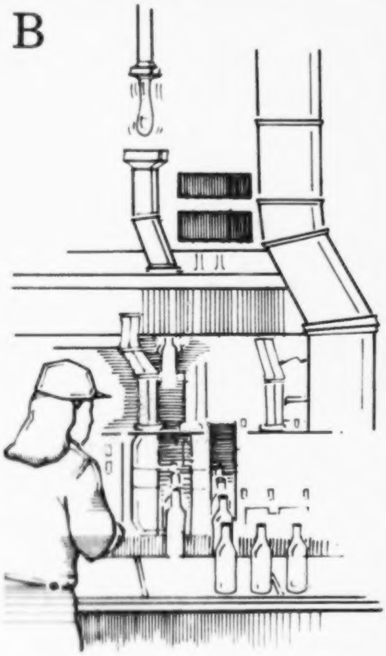
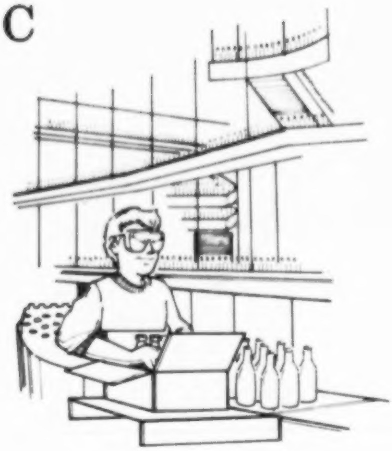
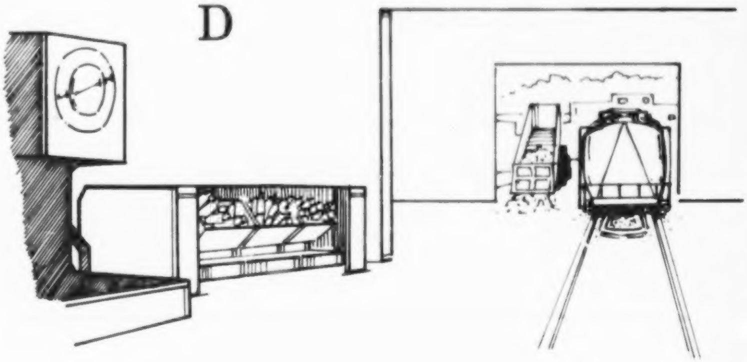
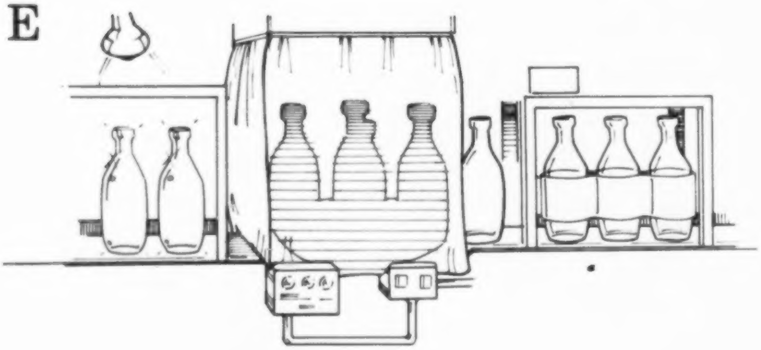
BOTTLE MAKING MACHINES

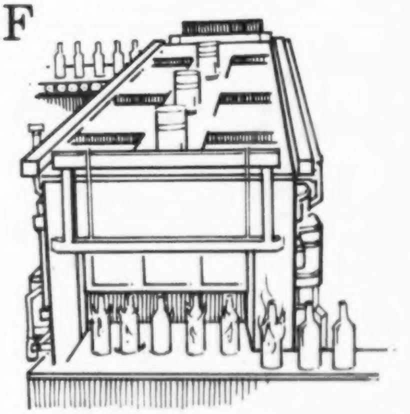












14 RECYCLING SYSTEMS MAKE SENSE

A GLASS FACTORY

Directions: Look at the pictures on the handout, ***Bottle Making Machines***. These machines make up a system that changes recycled glass bottles and jars into new bottles and jars. Place the pictures in the correct process order, and write a sentence to describe what is happening in each picture. Remember, even though you do not know exactly what is happening, try to guess. Put the letter of each picture beside the Step number you think it corresponds with in a process order. Then write sentences describing what is happening in each picture. Using these sentences write a paragraph adding a main idea sentence and a concluding sentence. Correct spelling and grammar errors. Rewrite a final draft.

Step 1 (Picture letter)

Step 2 (Picture letter)

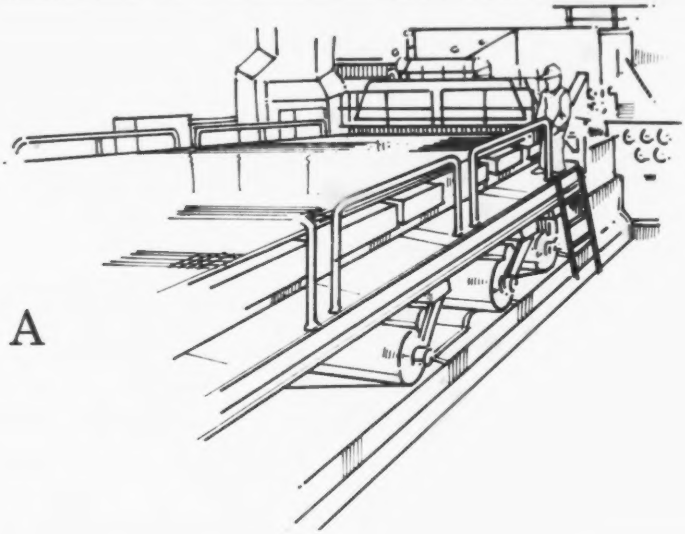
Step 3 (Picture letter)

Step 4 (Picture letter)

Step 5 (Picture letter)

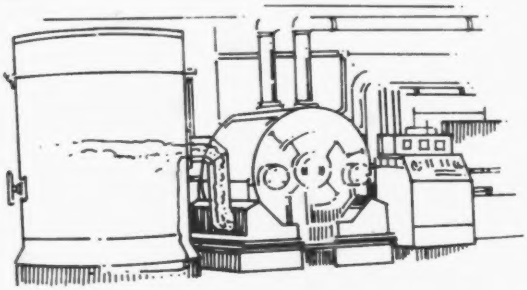
Step 6 (Picture letter)

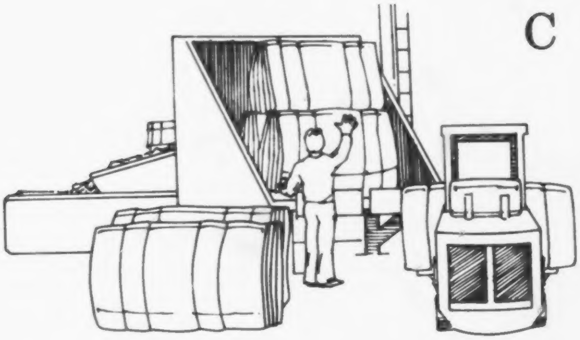
PAPER MAKING MACHINES



A

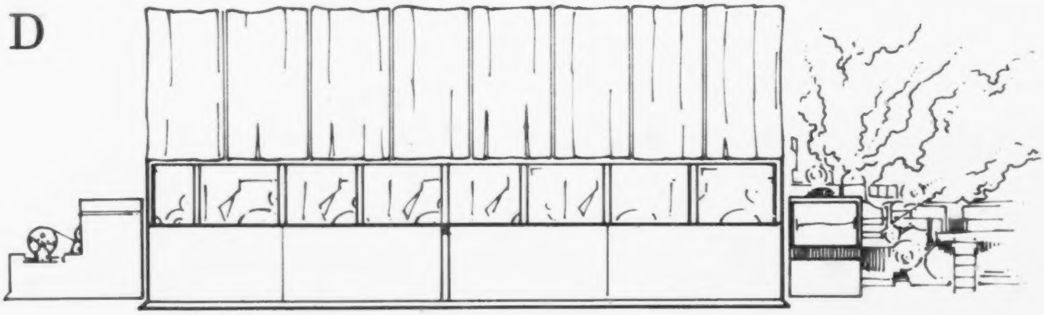
B



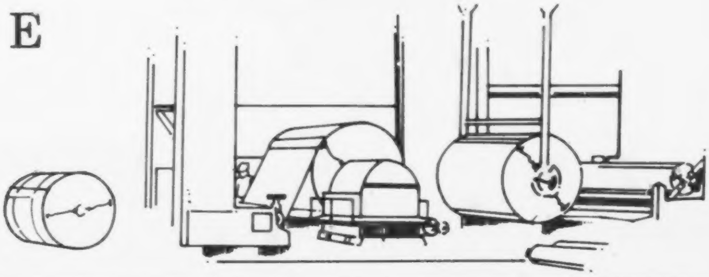


C

D



E



14 RECYCLING SYSTEMS MAKE SENSE

A PAPER MILL

Directions: Look at the pictures on the handout, ***Paper Making Machines***. These machines make up a system that changes recycled cardboard into new paper for use in making new cardboard boxes. Place the pictures in the correct process order, and write a sentence to describe what is happening in each picture. Remember, even though you do not know exactly what is happening, try to guess. Put the letter of each picture beside the Step number you think it corresponds with in a process order. Then write sentences describing what is happening in each picture. Work by yourself to decide what to write. Using the sentences you have written, write a paragraph adding a main idea sentence and a concluding sentence. Correct spelling and grammar errors. Rewrite a final draft.

Step 1 (Picture letter ________) ____

____

____

Step 2 (Picture letter ________) ____

____

____

Step 3 (Picture letter ________) ____

____

____

Step 4 (Picture letter ________) ____

____

____

Step 5 (Picture letter ________) ____

____

____

TEACHER INFORMATION

This information contains explanations of the recycling machines in each recycling system. The correct order and explanations are listed below under the title of each system.

CAR SHREDDING PLANT

STEP 1: (Picture D) Car bodies are shipped to the car shredding facility on a large flatbed truck. (Most reusable parts, such as engine parts, batteries and tires, have been stripped from the bodies.) Sometimes the cars arrive already flattened. A large crane lifts the car bodies off the truck.

STEP 2: (Picture B) The crane lifts the car bodies into a giant machine where the cars are compressed and shredded into tiny pieces.

STEP 3: (Picture C) Small pieces of metal come out of the giant shredder and fall onto a conveyor belt. As the belt moves, foam rubber, cloth and dirt are sucked away from the metal pieces by a big vacuum.

STEP 4: (Picture E) The metal scrap continues up another belt to a magnetic separator. Here nonferrous metal scrap (aluminum, copper, brass) drops onto another belt which lifts these metals up to a separate pile.

STEP 5: (Picture A) The ferrous pieces that stay on the magnetized belt are dropped onto another long belt which drops these pieces onto a big pile.

A GLASS FACTORY

STEP 1: (Picture D) Recycled glass is brought in from the community to a drop off point or hauled in by trucks from different sources. Additional raw materials needed to produce recycled glass, such as soda ash and sand, are brought in by truck and train.

STEP 2 (Picture A) Raw materials and recycled glass cullet (crushed pieces of glass) are mixed into a batch and stored in cylinders in the furnace feeding area. Hot furnaces melt the batch into molten glass at an average temperature of 2700°F.

STEP 3: (Picture B) From the furnace, the molten glass flows through an orifice and is cut into a glob. The glob of hot glass drops into preforming molds, then into a blow mold where glass containers are given final shape.

STEP 4: (Picture F) Glass containers move on a conveyor belt from the molding machine to an oven (called a "lehr") where the glass is strengthened as temperatures are raised and lowered slowly in order to anneal the glass.

STEP 5: (Picture E) Bottles are inspected and tested. Bottles are visually inspected with bright lights. Special electronic machines take pictures of each bottle to identify defects such as tiny bubbles or chipped glass. Each bottle is also squeeze tested with others at one time.

STEP 6: (Picture C) Workers make a final inspection of the bottles and package them into cartons that are sent to the shipping warehouse.

A PAPER MILL

STEP 1: (Picture C) Recycled paper or cardboard is stored in bales until needed. The scrap in this example is recycled corrugated cardboard containers. The scrap is placed in a large tank called a hydrapulper where it is made into pulp by agitation with water.

STEP 2: (Picture B) Wood chip pulp and some chemicals are mixed with the recycled paper pulp in a large tank and pumped into double disk refiners to obtain fiber length and necessary quality.

STEP 3: (Picture A) The Fouldrinier machine is next. In this machine wet pulp flows out of the headbox onto a moving screen. The screen with pulp runs across a large surface area and down through rollers beneath the machine. The sheet of paper is formed continuously on the screen as water is drained from the pulp through the wire.

STEP 4: (Picture D) The wet paper is transferred from the screen onto a belt which carries the sheet through two presses. The presses remove water from the newly formed paper by means of pressure. The drying process continues as the paper is next sent through a series of seventy-two dryers. These dryers are steam heated cylinders that evaporate water from the paper sheet as it rolls over them. The paper is wound on rolls as it exits from the dryers.

STEP 5: (Picture E) The dried paper is then rewound on a rewinder. This big roll on the rewinder is moved to a cutter where the roll of paper is cut to exact specifications. As it is cut, the paper is rewound on a final roll ready for shipping.

Chapter 15

Citizens to the Rescue

RULING OUT LITTER

CHAPTER 15

LITTERING
IS AGAINST
THE LAW

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *identify* and *explain* the purpose of rules and sanctions against littering; (2) make rules and sanctions to prevent littering by choosing from alternatives. Students will improve their abilities to *cooperate with others* and to *solve problems*.

Method

Following a discussion of rules and sanctions and of litter laws in Ohio, the students investigate and collect information about littering habits in their own classroom and school. They establish model community councils to vote on rules and sanctions for the class to abide by the rest of the school year. Students write about their feelings and construct an illustrated booklet about their classroom litter laws and sanctions.

Duration: initially, four to five class periods followed by yearlong participation at selected times

Setting: classroom, school

Subjects: Social Studies, Language Arts, Art

Curriculum Reference: 7.2, 8.2

Preparation

writing materials

Vocabulary

community council, law, litter, rule, sanction

Handouts

Classroom Litter; School Litter; Littering In Ohio

Procedures

1. Make plans for your classroom to become a *littered* neighborhood for three days to one week. During this time waste items (that are not a health hazard) are *not* to be deposited in containers but rather left on the floor or around the room. Following the period of littering, record data by using the handout, ***Classroom Litter***. Discuss answers and have a cleanup party. Then have students identify places in or around the school where litter exists by filling out the handout, ***School Litter***.

2. Explain to students, and discuss the need for, *rules* and *sanctions* at home, at school and in the community. Identify the need for rules and sanctions about littering. Read the following passage to students.

   Under Ohio law, litter is any kind of trash thrown or dropped by a person on public property, or on private property not owned by the person, or in the state's waterways.

   Discuss illegal dumping as a serious form of littering that can be harmful to human health. Explain that littering is punishable by as much as a $500 fine and/or sixty days in jail and that some forms of illegal dumping can be punishable by harsher jail sentences and steeper fines. Have students complete the handout, ***Littering In Ohio***, and discuss. This handout could also be used in pre- and post- test fashion.

3. Discuss with students how communities make ordinances and states make laws to prevent littering. Litter ordinances and laws are really *rules* given formal sanctions. Tell students that rules are also needed in classrooms and that by setting up a model community in the classroom, classroom rules can be made democratically and enforced.

4. Create a model classroom community to make and pass rules and sanctions about littering. Below are some suggestions.

©1988 Ohio Department of Natural Resources; source: Jo Parkey, Smith Middle School (Vandalia, Oh); Rosalie Spencer, East Elementary (East Liverpool, Oh) and Marilee King, Olive Hill Elementary (Trotwood, Oh).

a. Establish one *Classroom Community Council* and various *Classroom Neighborhood Councils* to submit proposals to the Community Council. The Community Council could be created by classroom nominations and voting to choose five students to make up the council. The rest of the class could be divided into Neighborhood Councils associated with various places in the classroom (learning center, lockers) and school (library, lunchroom, gym, playground, etc.). Allow students to choose which neighborhood councils they want to be on, but limit the numbers for each neighborhood council based on size of neighborhood and potential to be littered (i.e. the locker area in the classroom could be limited to three students, while the playground might have five students). You may also wish only to create neighborhoods within the classroom to simplify procedures which follow.

b. Have each Neighborhood Council recommend (after meeting in groups) some rules and sanctions for classroom (and school) littering behaviors based on the neighborhood area (in the classroom or school) which each represents. The handouts completed in Step 1 above should give students ideas regarding what type of litter problems exist in their areas. Some examples of rules might be the following:

- When cutting paper during art projects, put reusable pieces in the "art scrap box."
- When a task is completed at a learning center, put all items in the proper place.
- Put trash found on the floor into the waste basket.

Some examples of sanctions for these rules might be the following:

- Lose the privilege to participate in one art project. (Council chooses which project.)
- Lose a privilege to work at a learning center for one day.
- Lose five minutes of recess.

c. The Community Council should then meet to consider which of the rules should be adopted and hold a classroom vote on each.

d. The Community Council may want to select from volunteers three or four students to enforce the laws.

e. Remember to reinforce the implications of this activity: that students will have to abide by these rules for the entire year. (Unless they decide to petition for amendment or to make updates.)

f. Construct a litter chart to record trash on the loose in the classroom for the remainder of the school year, along with infractions and sanctions.

Evaluation Have students write about their positive and negative feelings concerning the rule-making experience. Their work can be consolidated in a class booklet with illustrations that highlight the rules and sanctions they created.

CLASSROOM LITTER

Directions: List litter found in the following places and answer the questions below.

DESK	LOCKER AREA

SHELVES	OTHER PLACES (Describe Place & Litter)

1. How did you feel working in a littered classroom?

2. What would happen if we kept littering our classroom?

SCHOOL LITTER

Directions: List litter found in the following places.

PLAYGROUND

LUNCHROOM

HALLWAYS

OTHER PLACES (Describe Place & Litter)

LITTERING IN OHIO

Directions: Circle the letter of the correct answer/answers to each question.

1. Under Ohio law, litter is:
   a. a rose bush in a yard.
   b. a pop can thrown in Mrs. Greene's yard by Bobby French.
   c. a chair falling from a pick-up truck.
   d. trash can in a park.
   e. tires in a river.
   f. a bird bath in a yard.
   g. a broken doll in a creek.
2. Name three other examples of littering.
   a. ____________________________
   b. ____________________________
   c. ____________________________
3. Does a person break the law when he/she litters?
   a. yes b. no
4. If a police officer sees a person littering, can that person be arrested?
   a. yes b. no
5. When a person is caught littering they may have to:
   a. promise not to litter again.
   b. pick up the litter.
   c. pay a fine.
   d. spend time in jail.
6. What can happen to people that dump waste where it is not to be dumped?
   a. lose their driver's license.
   b. pay a fine.
   c. spend time in jail.

IT HAS TO BE DEALT WITH

CHAPTER 15

PRIMARY/INTERMEDIATE

Objectives

Students will be able to: (1) *identify* facilities for waste management that are required to meet a community's needs; (2) *suggest alternatives* for waste disposal. Students will improve their abilities to *plan* and *solve problems.*

Method

Students design model cities based on a listing of needs. Waste management issues are discussed and waste management plans adopted for a model city, with students designing plans in groups.

Duration: seven to eight class periods

Setting: classroom

Subjects: Social Studies, Arts & Crafts

Curriculum Reference: 5.1, 8.2

Preparation

Depending on choice for designing a model city you may need: a. pencils, rulers, construction paper, crayons or markers, glue and a large mural size sheet of paper; or, b. throwaway, cleaned items such as milk cartons (various sizes, but ½ pint to 1 quart sizes work best), styrofoam cups, popsicle sticks, match boxes and other items that could be used to construct buildings for scale model communities.

Vocabulary

scale model, solid waste management planning

Procedures

1. Divide the class into small groups. Have each group make a list of all the necessary and important places that are usually found in a typical city (homes, schools, stores, shopping malls, hospitals, offices, factories, parks, etc.). When lists have been compiled start with one group's answers and list on the board. Ask other groups what can be added to this list. Do not prompt students to think of waste management concerns, but if groups have listed places associated with waste management put these in a separate column. Solid waste management concerns could include the following: garbage collection vehicle garage, landfill, incineration plant, recycling collection centers, waste transfer station, etc.

2. Based on the class listing now on the board, excluding the waste management concerns, have each group design a model city by either: a. designating where various places could be on a large mural size sheet of paper, adding colors and construction paper cutouts for buildings and roads; or, b. constructing a model community using items listed in "b" in **Preparation** description above.

3. After model cities have been designed ask students what all of these places have in common. They generate waste. Discuss the need for waste management and make a list of places associated with waste management if the concern had not been previously mentioned, or add to list of places students have already mentioned.

4. Each group can now use the list of waste management concerns to design a waste management program for their model community. After doing so, have each group defend their plan while the others try to notice shortcomings of the plan. Did the group choose to have an incinerator to lessen the need for landfills but risk air pollution? Why was a landfill sited where it was? Have recycling collection centers been created? Perhaps neighborhood source separation programs have been established. Are recycling centers in convenient places? There are

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many variables to discuss. You might have a prize for the most comprehensive waste management design or scale model (meaning the group that considered the most concerns related to the subject of waste management).

Evaluation Put a map of your county on the bulletin board identifying undeveloped areas outlined by a colored marker. Also, designate where waste management facilities of all types are located, including recycling centers. Have students decide where the best place would be to establish either a landfill and/or an incinerator. Have them justify their answers. Then have them decide where the worst place would be to establish either a landfill and/or incinerator and justify their answers. Do the same exercise in regard to the establishment of a recycling center.

YOU HAVE A VOICE

CHAPTER 15

INTERMEDIATE

Objectives Students will be able to *identify* and *explain* conflicting viewpoints regarding the use of community land for purposes of waste management. Students will improve their ability to *cooperate in groups.*

Method Students choose characters, from descriptions on a handout, to role-play at a town council meeting. They infer the viewpoint of their character regarding a variety of land use issues and express views in a group setting (town council meeting). They *analyze alternatives and* positive and negative *consequences.* They *write* newspaper articles about the town council meeting.

Duration: four to five class periods

Setting: classroom

Subjects: Social Studies, Language Arts

Curriculum Reference: 6.1, 7.1, 8.2

Preparation In this activity you may wish to reproduce the wheel (in the handout, ***Wheel of Waste Issues***) on the board or construct a large class wheel from tagboard or poster board. Students may wish to research their characters by interviewing community officials or reading material from the local library before role-playing.

Vocabulary community council, hazardous waste, landfill, land use, recycling center, waste management

Handouts ***Characters and Conflicts; Wheel of Waste Issues***

Procedures

1. Motivate students with a discussion of the questions that follow: What have you observed about vacant land in your neighborhood or community? What do you consider the ideal use for vacant land in your neighborhood or community? As you discuss these questions make sure students understand the meaning of the vocabulary words listed above.
2. Using the *role-play wheel* discuss the different characters and have students infer from the description what that person might feel toward a possible suggested use of 150 acres of vacant community land. Pick one of the *conflicts* not directly associated with waste problems for this initial introduction to the activity.
3. Have students divide into groups where each student will become a character at a town council meeting to present his/her views on what he/she feels about one of the conflicts presented. Use handout, ***Characters and Conflicts***, to help students. Students will prepare a character and participate in the town meeting.
4. The wheel is designed to be used in many ways. The chart can be used to portray each character in different situations so you might have each group choose a different situation. Or, students could role-play characters responding to several situations. The wheel could also be used in writing an individual story about the characters and what he/she might feel about any of the conflicts. Be creative!

Evaluation As each group holds their town council meeting, have students in the other groups write a newspaper article (or general description) about the town meeting, including views of various officials and whether the conflict was resolved, etc. Prompt students to find newspaper articles about issues like those role-played and bring these to class to discuss.

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CHARACTERS AND CONFLICTS

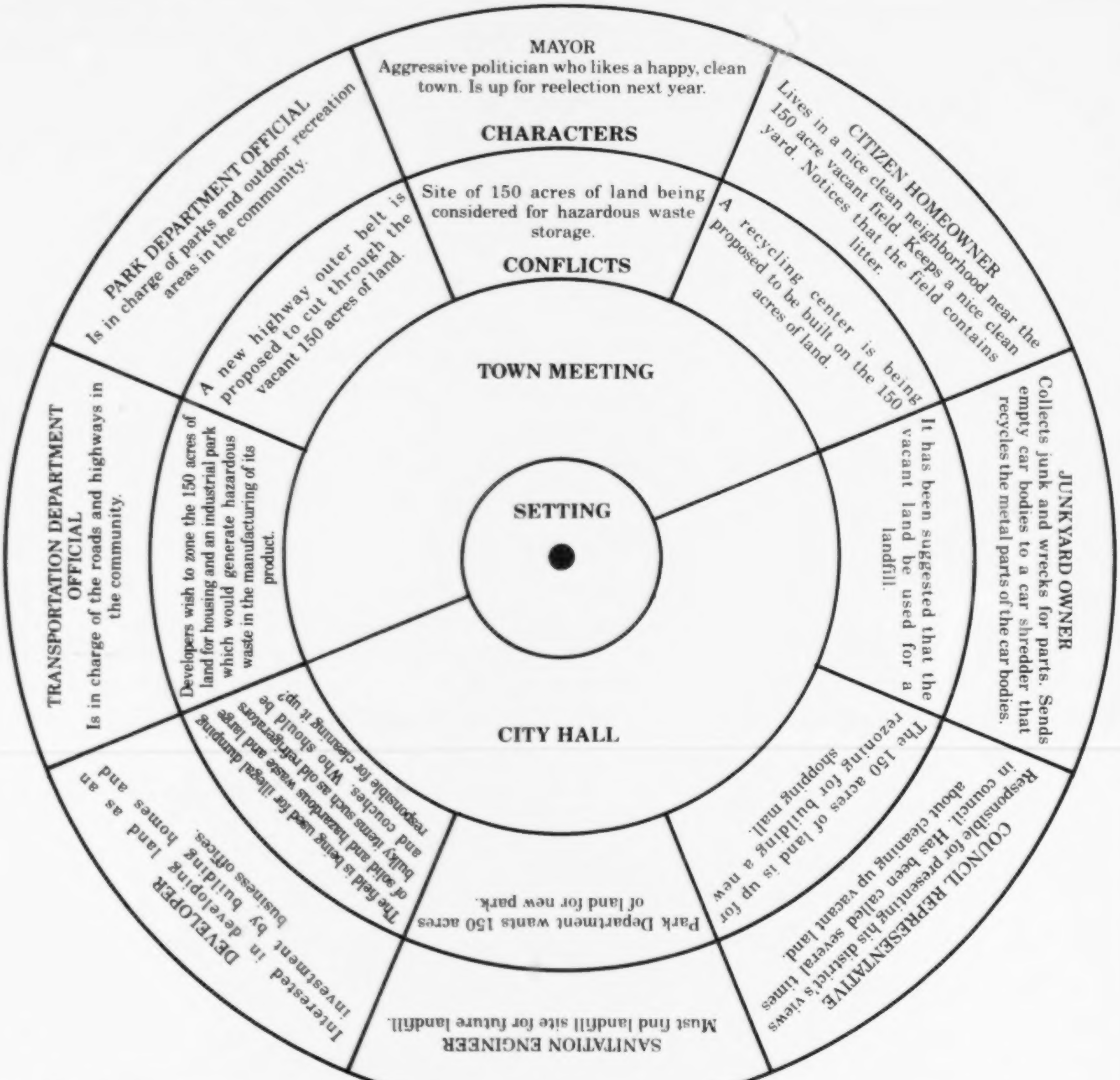
Directions: Fill this form out before you attend the town council meeting. Try to find facts in newspaper articles or news reports that might help prove your point. Maybe some things you have studied in books could help you.

MY CHARACTER FOR THE TOWN MEETING IS: ______________________________

THE CONFLICT MY GROUP HAS CHOSEN IS WRITTEN IN THE SPACE BELOW:

THIS IS HOW I THINK MY CHARACTER WOULD FEEL ABOUT THE ABOVE CONFLICT, AND I INTEND TO MAKE IT KNOWN AT THE TOWN MEETING THAT I FEEL STRONGLY ABOUT IT. I HAVE LISTED THE REASONS I FEEL THAT WAY IN THE SPACE BELOW.

WHEEL OF WASTE ISSUES



MAYOR
Aggressive politician who likes a happy, clean town. Is up for reelection next year.

CITIZEN HOMEOWNER
Lives in a nice clean neighborhood near the 150 acre vacant field. Keeps a nice clean yard. Notices that the field contains litter.

JUNKYARD OWNER
Collects junk and wrecks for parts. Sends empty car bodies to a car shredder that recycles the metal parts of the car bodies.

COUNCIL REPRESENTATIVE
Responsible for presenting his district's views in council. Has been called several times about cleaning up vacant land.

SANITATION ENGINEER
Must find landfill site for future landfill.

DEVELOPER
Interested in developing land as an investment by building homes and business offices.

TRANSPORTATION DEPARTMENT OFFICIAL
Is in charge of the roads and highways in the community.

PARK DEPARTMENT OFFICIAL
Is in charge of parks and outdoor recreation areas in the community.

Site of 150 acres of land being considered for hazardous waste storage.

A recycling center is being proposed to be built on the 150 acres of land.

It has been suggested that the vacant land be used for a landfill.

The 150 acres of land is up for rezoning for building a new shopping mall.

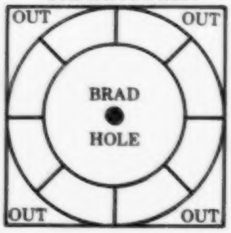
Park Department wants 150 acres of land for new park.

The field is being used for illegal dumping of solid and hazardous waste and large bulky items such as old refrigerators and couches. Who should be responsible for cleaning it up?

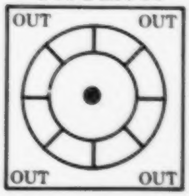
Developers wish to zone the 150 acres of land for housing and an industrial park which would generate hazardous waste in the manufacturing of its product.

A new highway outer belt is proposed to cut through the vacant 150 acres of land.

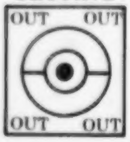
CHARACTERS



CONFLICTS



SETTING



Make three copies of the wheel. Cut out each section as indicated. Fasten together on tagboard with wire brad.

FISHY FISH

CHAPTER **15**

INTERMEDIATE

Objectives

Students will be able to: (1) *hypothesize* about the possible causes and sources of water pollution in a community. Students will improve their abilities to *cooperate in groups* and to *solve problems.*

Method

Students use a variety of information on handouts to identify symptoms of water pollution, possible environmental causes and community sources of water pollution. They cooperate in investigation teams to present a report about specific pollution problems identified on a map of a model community.

Duration: eight to nine class periods

Setting: classroom

Subjects: Science, Social Studies

Curriculum Reference: 3.2, 4.2, 5.1, 8.2

Preparation

writing materials and reference sources

Vocabulary

environmental investigation, improper waste disposal, water pollution, proper waste disposal, town council; special words on handout, ***Possible Community Sources of Pollution***: consumer waste, detergent, fertilizer, hazardous waste, heavy metals, herbicide, leachate, oil, organic waste, pesticides, phosphorous

Handouts

Fishville; Observations of Concerned Citizens of Fishville; Possible Causes of Observable Signs of Pollution; Possible Community Sources of Pollution

Special Note: The examples of pollution in this activity happened frequently prior to our awareness, in the late 1960's and 1970's, of the threat to the environment posed by these forms of pollution. Within the last twenty years local and state governments and the national government, in conjunction with businesses and industries, have taken measures — including the treatment of wastes, careful disposal, regulations and enforcement — to considerably reduce the chances that the possible sources of pollution identified in this activity will be conduits for harmful wastes to enter the environment. However, accidents happen and examples of negligence and willful illegal dumping of hazardous materials still take place.

Procedures

1. Have the class divide into groups and give each group a copy of the map of **Fishville**. Each group is to represent an environmental investigation team appointed by the town council of Fishville.
2. Give each group the handout, ***Observations of Concerned Citizens of Fishville***. Clarify the directions, have students complete the handout and then discuss the words each group has identified. Refer to answer key for answers and have each group make corrections accordingly.
3. Each investigation team must research and prepare a report for the town council identifying possible causes of the pollution which have been observed and possible sources of this pollution in the community. To help teams identify possible causes and sources give them the handouts, ***Possible Causes of Observable Signs of Pollution*** and ***Possible Community Sources of Pollution***. These two handouts, used in conjunction with the map and the handout, ***Observations Of Concerned Citizens***, provide much, but not all, the information necessary to identify the possi-

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ble causes and sources of pollution in each lettered area on the map. For example, by using the handouts, the following explanation for location "A" could be given:

> Foam (in ***Observations of Concerned Citizens*** handout) can be caused by soap and detergents (see ***Possible Causes*** handout), which may be coming from the car wash (see ***Possible Community Sources***). The *strange odors* may be caused by organic waste which could be coming from the sewage treatment plant; also dead fish from the fishing pier may cause the odor. The water may be *discolored* because of rust or paint chipping off the pier, or it could be discolored from organic waste which could be coming from the sewage treatment plant, or from car rust which could be coming from the car wash.

Make sure as students write their descriptions that they indicate the hypothetical nature of their claims, which require further investigation. Words such as *could, might, may be, possible*, etc. are important in this situation. After giving the above example for location "A" to students, you may wish to assign each group a particular pollution spot (or spots) to investigate: "B," "C," "G," "H," etc.

Note: Before students begin this exercise or as they proceed with it, they will need to learn the definitions of certain words. The following words found in the handout, ***Possible Community Sources of Pollution***, are very important for students to understand: organic waste, consumer waste, toxic waste, detergent, phosphorous, feces, heavy metals, pesticide and fertilizer. Either define these with the class before beginning this exercise, or have reference materials on hand for them to use to look up the words on their own.

4. In their report, each group could use reference materials to suggest possible reasons why a possible community source of pollution might be causing the pollution described. This means investigating (researching) the types of waste generated by "COMMUNITY CONCERNS" listed on the handout, ***Possible Community Sources of Pollution***. This also means investigating what the proper methods of waste disposal are for these residences, businesses, industries, farms, etc. and why problems sometimes arise which result in improper disposal by these concerns. (Remember that most residential waste and much waste from business and industry is disposed of in landfills. Therefore, an improperly run landfill could be a conduit for, say household, industrial and hospital wastes to pollute an area not in the region where they are located.)
5. Research conducted in Step 4 above could also be used to indicate, in the case of the COMMUNITY CONCERNS, which sources are the most likely to be contributing to a particular form of pollution and which are least likely to be contributors.
6. Have each group give their report to the class. NOTE: The pollution problem designated by the letter "G" can be traced back to many sources and/or to a very harmful, serious source of pollution which can affect human health by causing birth deformities and cancer. This is the group of pollutants described as heavy metals. (On the map their source would most likely be the "Abandoned Industrial Plant.") The hypothesis which describes how this and other types of pollution can take a while to have harmful effects on human health can be described as follows:

   > Through the food chain, fish can absorb and retain harmful chemicals in their bodies. If people eat fish contaminated by this form of pollution, then these harmful chemicals can affect human health.

   Given the special significance of "G" you may wish to exclude "G" from initial consideration by the investigation groups, and have all groups make reports about "G" in a second phase of the activity. ("G" could also serve as an evaluation exercise.)
7. After all reports have been made have each group rank order the pollution cases, "A" through "J," from the case which they feel has the potential to be the least harmful to life, to that which they feel has the potential to be the most harmful to life. Have them present reasoning for their choices.

Evaluation

Have students list ten ways in which our waterways can become polluted if waste is not disposed of properly. Have students go to the library and find three articles in newspapers and/or magazines representing three different examples from this list.

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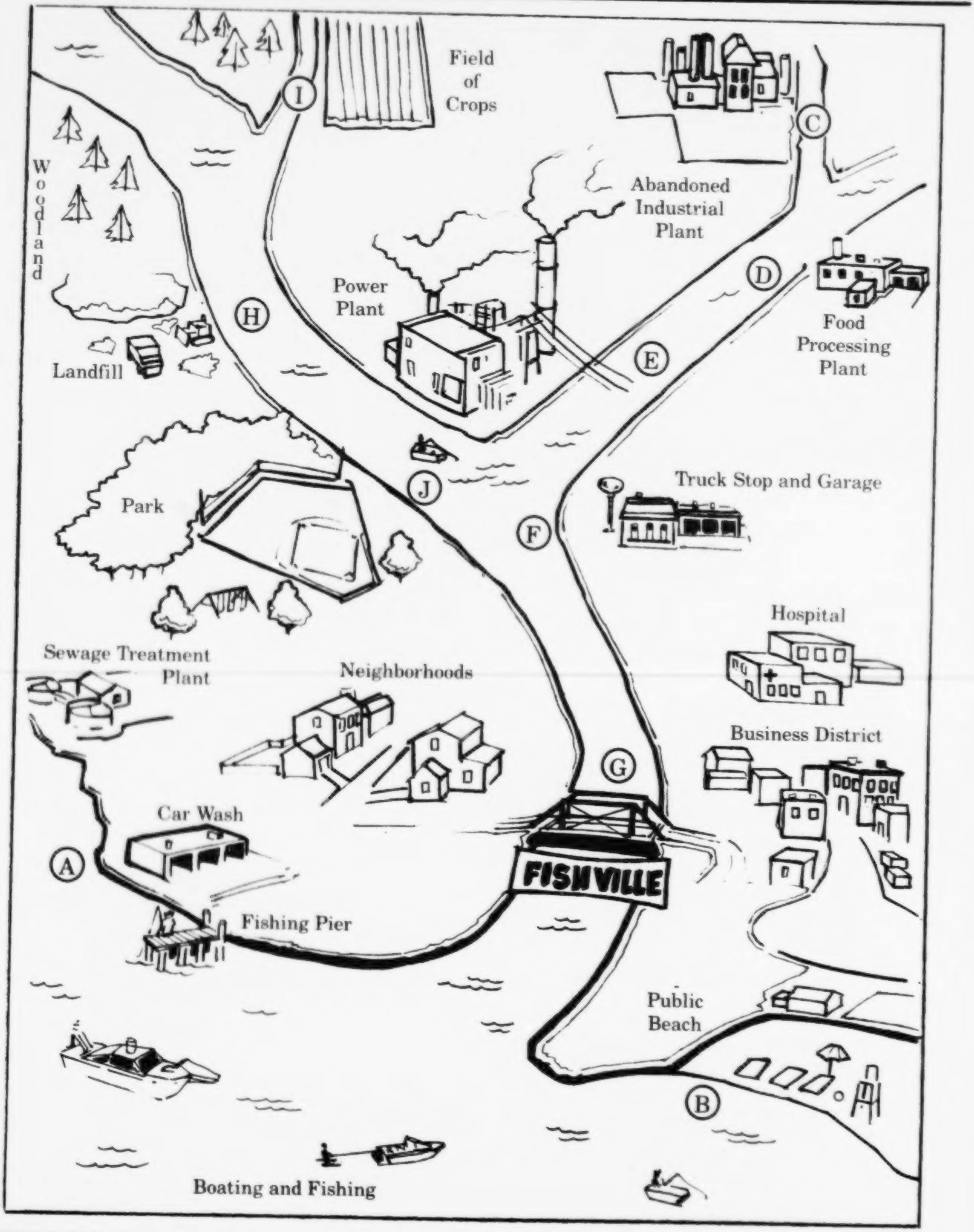
Field of Crops
Woodland
I
C
Abandoned Industrial Plant
Power Plant
D
H
E
Food Processing Plant
Landfill
J
Truck Stop and Garage
Park
F
Hospital
Sewage Treatment Plant
Neighborhoods
Business District
G
Car Wash
A
FISHVILLE
Fishing Pier
Public Beach
B
Boating and Fishing

15 FISHY FISH

OBSERVATIONS OF CONCERNED CITIZENS OF FISHVILLE

Directions: Your group role as an environmental investigation team is to find out more about the observations below which have been reported to the town council by citizens of Fishville. First, you need to identify key words in the report that indicate forms of pollution. So underline the key words in each of the ten location descriptions that are signs of pollution which can be seen, or felt, or smelled.

In **Location A** there is foam along the shore line and there are strange odors. Water along the shore is discolored by a cloudy grey tint.

In **Location B** there is litter: cans, bottles and plastic bags in the water near the beach.

In **Location C** no fish have been caught or seen near this stream. There is a slight discoloration of the water and an over abundance of sand at this point in the stream.

In **Location D** algae are increasing on the water and rocks and few fish are caught anymore.

In **Location E** some fish with tumors have been caught.

In **Location F** there is a visible sheen (film) on the water that reflects different colors as the sunlight shines on it.

In **Location G** some fish with tumors have been found floating dead in the water.

In **Location H** the water is discolored and has a strange odor.

In **Location I** the water is muddy-brown looking and algae is forming.

In **Location J** the water is warmer here than upstream or downstream.

POSSIBLE CAUSES OF OBSERVABLE SIGNS OF POLLUTION

FOAM — can be caused by soap or detergent which often contains phosphorous.

ODOR — can be caused by organic waste such as feces, decaying food, urine.

DISCOLORATION — can be caused by organic waste such as decaying food and feces and from dyes, paints, rust and many other things.

LITTER — caused by human beings failing to put waste in a container.

NO FISH OR DEAD FISH — toxic substances can keep fish from reproducing and from living by killing smaller fish and other organisms they feed on.

FEW FISH — something may be changing fishes ability to eat, breath or reproduce, so they move somewhere else.

SAND — used by industries to mix with heavy metals for the disposal of these metals.

ALGAE — growth is aided by decomposition of organic waste: food, feces, and by fertilizers. Algae growing rapidly use up so much oxygen in the water that fish do not get enough oxygen to live there.

VISIBLE SHEEN — can be produced by oil which floats on water.

TUMORS — could be caused by ingesting (eating) animals or plants that have absorbed toxic chemicals.

MUDDY WATER — can be caused by soil and dirt from land washed into the water by rains.

WARM WATER — can be caused by warmer water entering the river from a particular source.

POSSIBLE COMMUNITY SOURCES OF POLLUTION

COMMUNITY CONCERNS	TYPES OF WASTE PRODUCED
BOATING & FISHING:	Oil, consumer waste
BUSINESS DISTRICT:	Organic waste, consumer waste
CAR WASH:	Detergents and soap
PARK:	Organic waste, consumer waste
BOATING AND FISHING:	Oil, consumer waste, organic waste
HOSPITAL:	Organic waste, consumer waste, some hazardous substances associated with medicines or diseases
FIELD OF CROPS:	Pesticides, fertilizer, herbicides, organic waste
FISHING PIER:	Consumer waste, organic waste
FOOD PROCESSING PLANT:	Organic waste
LANDFILL:	Organic waste, consumer waste, leachate
NEIGHBORHOODS:	Organic waste, consumer waste
ABANDONED INDUSTRIAL PLANT:	Stockpiles of foundry sand containing heavy metals including lead, zinc, copper, cadmium
POWER PLANT:	Water used to cool down machines
PUBLIC BEACH:	Consumer waste
TRUCK STOP AND GARAGE:	Oil, organic waste
SEWAGE TREATMENT PLANT:	Organic waste
WOODLAND:	Organic waste (tree limbs, leaves, carcasses, etc.)